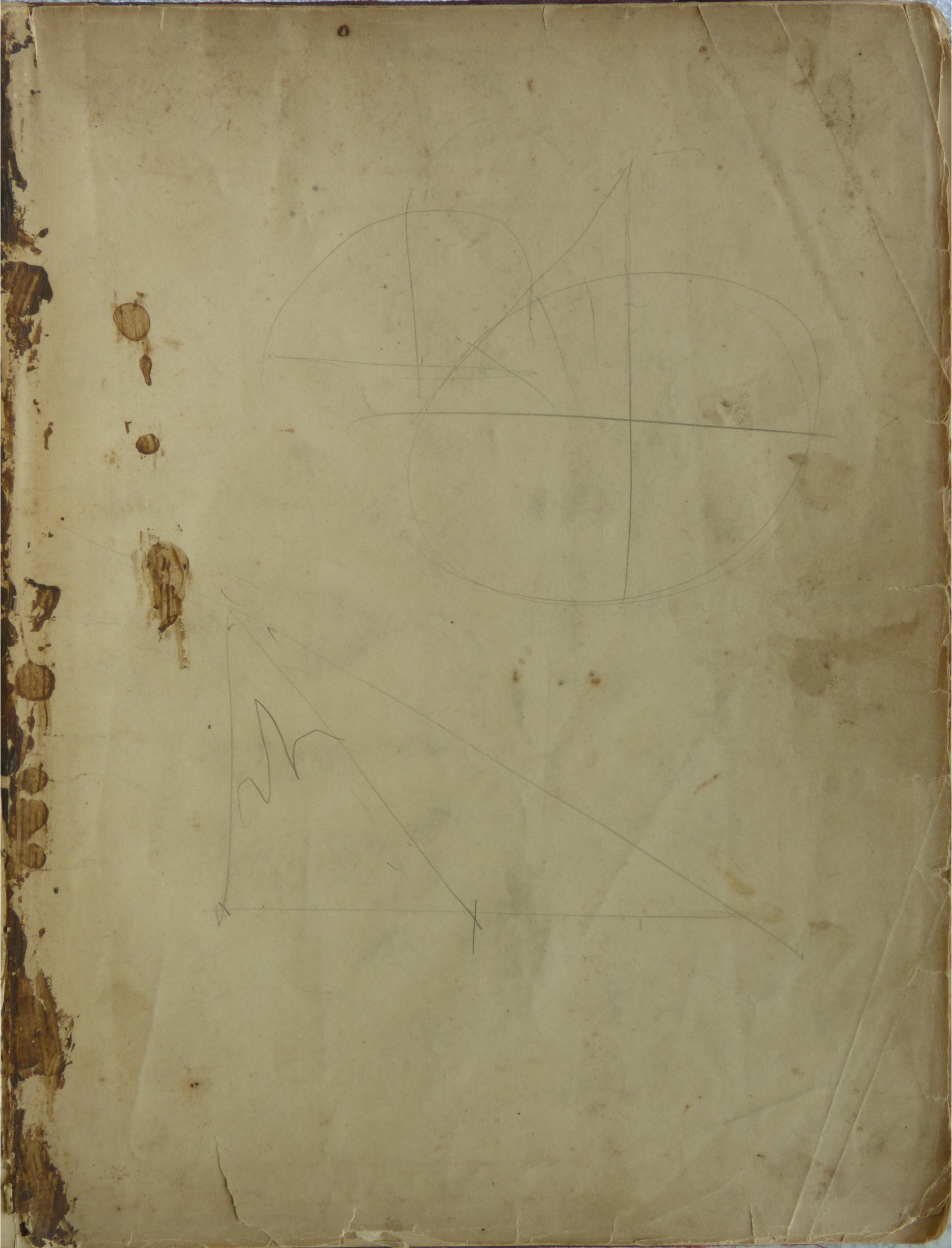
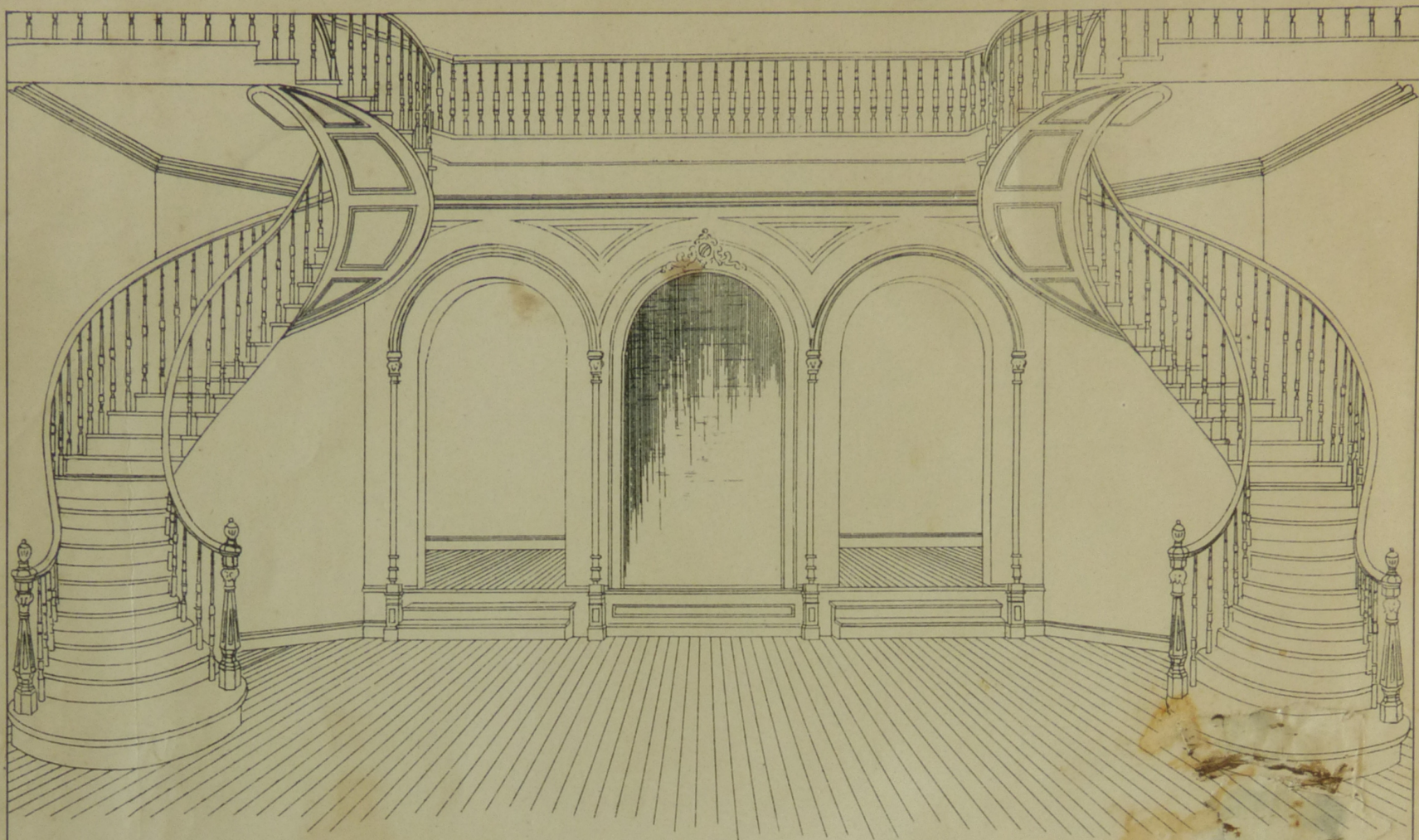


The
New Elements
of
HAND-RAILING

by

Robert Riddell





THE NEW ELEMENTS OF HAND RAILING



BY
R. RIDDELL.

THE NEW ELEMENTS^{OF} HAND-RAILING

Second Revised Edition.

CONTAINING FORTY-ONE PLATES, THIRTEEN OF WHICH ARE NOW FOR THE
FIRST TIME PRESENTED.

TOGETHER WITH ACCOMPANYING LETTER-PRESS DESCRIPTION. THE WHOLE GIVING A
COMPLETE ELUCIDATION OF THE ART OF STAIR-BUILDING.

BY
ROBERT RIDDELL,

AUTHOR OF

"THE ARTISAN;" "CARPENTER AND JOINER MODERNIZED;" "LESSONS ON HAND-RAILING FOR LEARNERS;" "THE
SLIDE RULE SIMPLIFIED, EXPLAINED AND ILLUSTRATED;" "MECHANIC'S GEOMETRY," ETC.



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PREFACE.

THE great favor with which my recent treatise on HAND-RAILING has been received, both in this country and in Great Britain, and the fact that it has been reproduced by some popular scientific serials in London, as a proof of that favor, (which I may scarcely hint is more profitable to my fame than my fortune,) induce me to once more present the public with some re-arranged instructions and illustrations. And I do this with the honest intention, not so much of enlarging on the subject in question, as of simplifying it still more.

Among the numerous and highly satisfactory letters with which correspondents have favored me since the appearance of the NEW ELEMENTS OF HAND-RAILING, was one that contained the following question, namely—"Could the bevels for the joints be produced upon the board itself, from which the mould is cut, perfection would be attained, and the subject fixed forever."

Acting upon this invaluable hint, I immediately recognized the necessity for revising my work; and in doing so I found it would be necessary to throw out a number of plates, replacing them with new, embodying the perfect elucidation of this problem, which is now final and conclusive.

I must here tender an apology to those patrons who have purchased my previous works, for thus apparently taxing them with a new book; but the object, which they as well as I must hold as desirable above all considerations, being at last obtained, is my plea for their renewed favor.

Being well aware that this revised edition will of necessity render its predecessors of less value, I proposed to the publishers to compensate their purchasers by giving them the *additional plates* and pages of printed matter now first presented, at a reduced price. My desire has been promptly and liberally complied with; and I feel, in consequence, that my friends lose nothing in the end, but rather gain, in the acquirement of a decided position on a problem of such value.

The London *Builder*, in a complimentary notice of the recent publication, [the New Elements of Hand-railing,] remarks, that kerfing was known long before my memory began. This is quite true. I am well aware that bending circular wall-strings, and other parts of joinery, by means

of kerfing, has been long in practice in England and in this country. But the mode adopted was uncertain, and could not be depended on, owing to a want of ability to determine with accuracy the exact distance between the kerfs. I claim to have reduced the operation to a system governed by positive rules, rendering it a certainty instead of a mere work of experiment.

PRACTICAL HINTS.

The principal lines in this system of Hand-railing consist of right angles and parallels. These may be readily drawn by using a framing square and straight-edge. Lay the latter on the drawing-board, fastening its end with a brad-awl. In applying the square, let one blade be against the straight-edge, and the other fair with the ordinate. The square being in this position, parallels are drawn with neatness and accuracy.

The next important line is called the *seat*, which must always be square with the ordinate.

Be certain to have the moulds correctly drawn and applied, so that the wreath may have its true cylinder form when in position.

In a word, let every line be correctly drawn, more especially those which show plumb bevels for joints.

The tools to be used, namely, *squares* and *bevels*, must be perfectly true; and this must be seen to and proved before using them, as it is utterly impossible to execute work properly, if the utmost dependence cannot be placed on the accuracy of these.

In many large structures, stone, instead of wood, is used for stairs; and it must, therefore, be borne in mind that the balusters (which are of iron) do not stand upon the treads, but on the outside of the nosings, supported on the stone strings, to which they are leaded and fastened.

The wreaths for such stairs should be prepared and bolted together to receive the iron band, which the smith fits to it, previous to fixing the balusters. This done, the rail may be moulded and completed.

ROBERT RIDDELL.

PHILADELPHIA, May, 1871.

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Plate 1

Fig. 1.

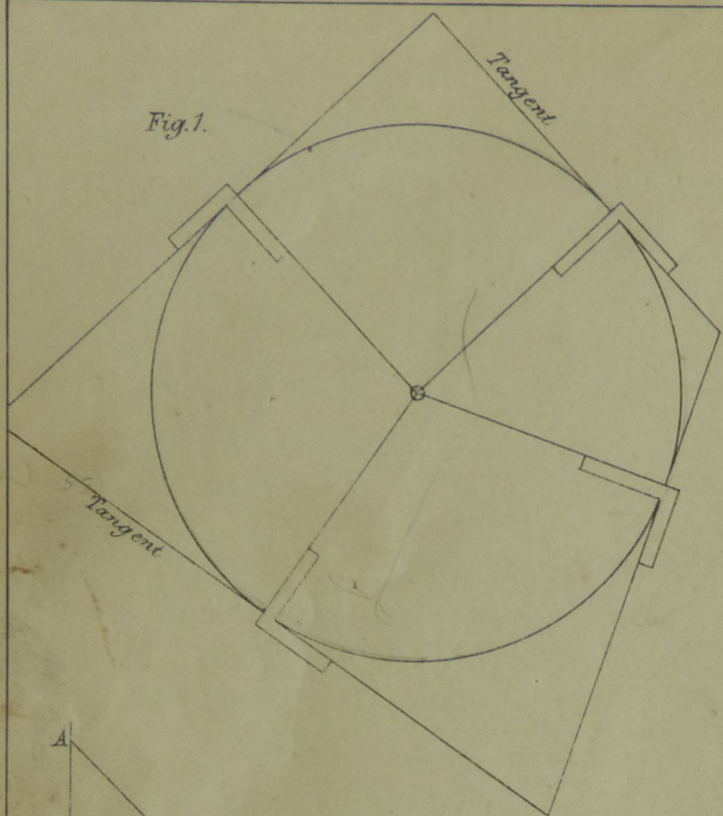


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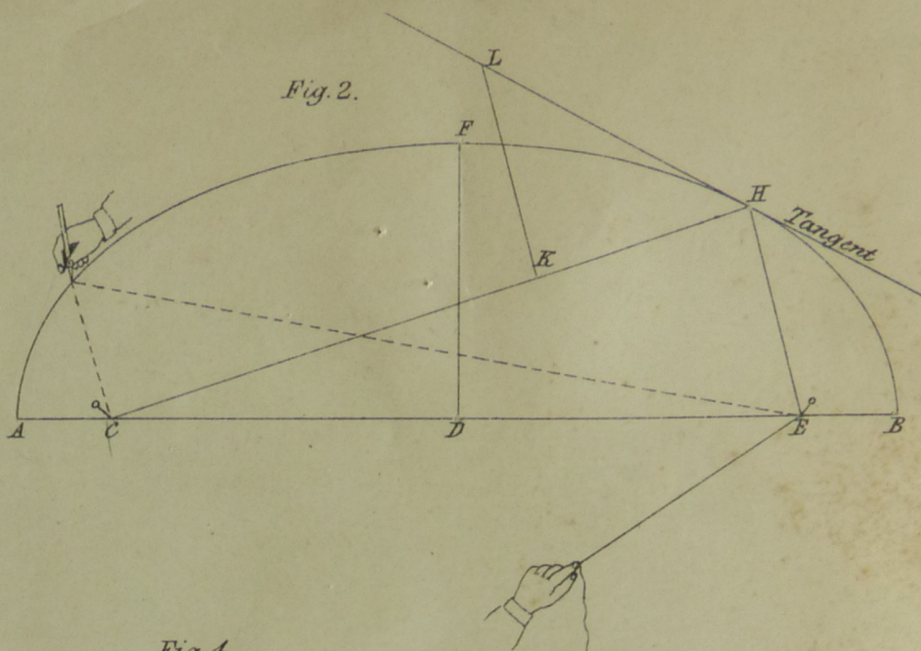


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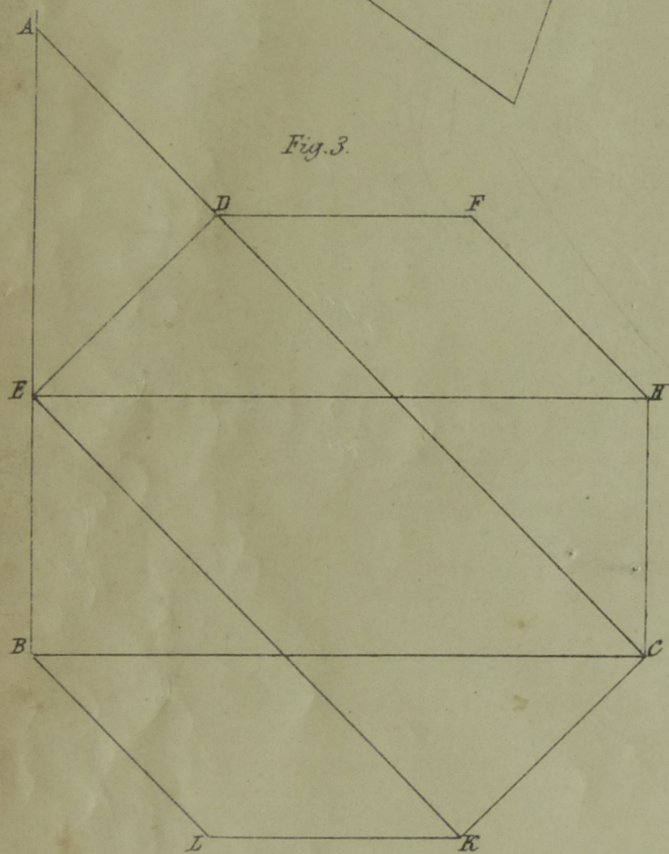


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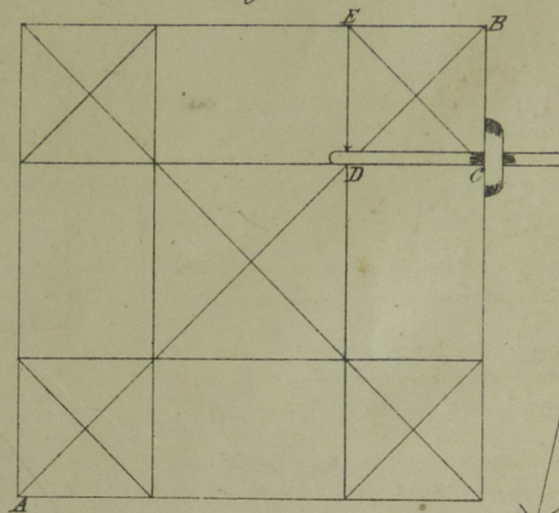


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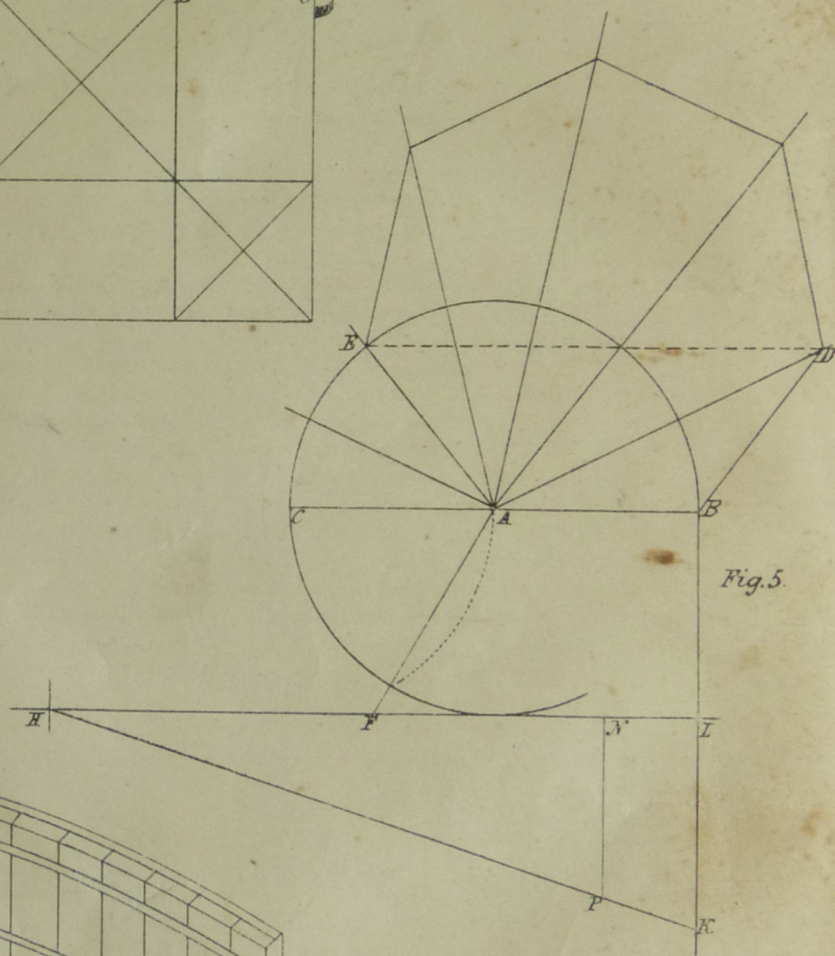


Fig. 6.

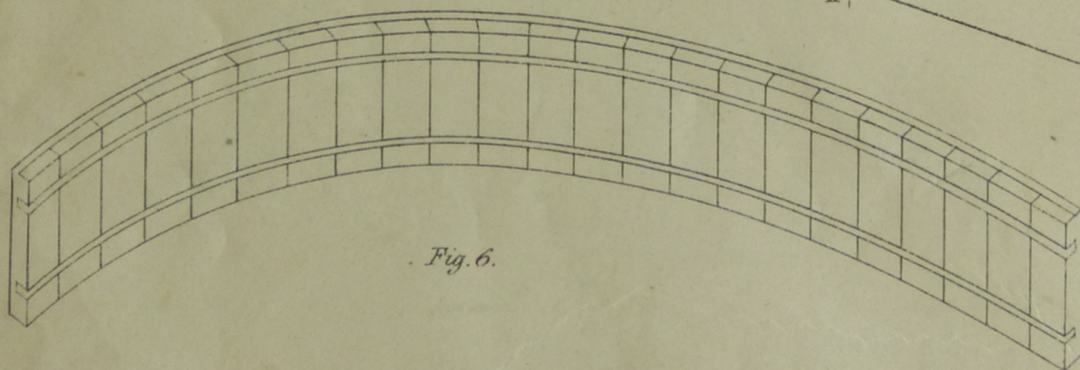


Fig. 7.

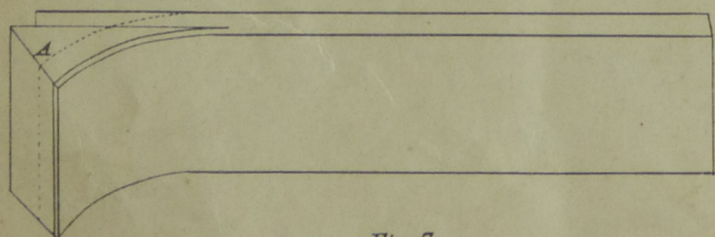


Fig. 8.

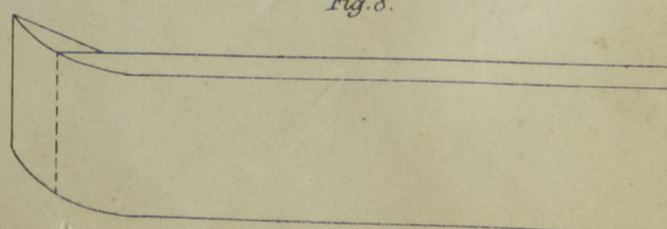


PLATE 1.

TANGENTS AND THE CIRCLE.

FIGURE 1. The formation and perfect construction of hand-rail wreaths depend entirely on tangents or straight lines touching the circumference of a circle. The point of contact, or where they exactly touch, is determined by drawing a line from centre O, cutting the circumference, thus fixing a point to draw a tangent, which must be always at right angles with said line from centre O.

Here it will be understood that a joint can be made on any part of a circle not exceeding half its diameter, this being the limit that a wreath can be formed in one piece; which is seldom required, and can be done only in certain situations.

The problem before us needs no further explanation. It is simple, and understood at a glance; yet it is the starting-point and foundation on which rest the whole system of hand-railing. Not a single movement can be made until the positions of joints and tangents are shown on ground-plan. This will be fully and practically explained as we proceed to examine one or two other problems equally simple, and, with their aid, endeavor to show that this elegant branch of joinery merely consists in the proper combination of a few lines arranged in such manner as to make this art a perfect and exact science; but by no means complicated or intricate in any of its parts.

Young beginners should be informed that no art, however simple, can ever be successfully acquired unless its elementary principles are first known. Let the learner bear this in mind, and carefully examine the first three or four plates of this work, which clearly show the meaning and intention of every line really necessary for the exact construction of any wreath, no matter what may be its shape or form.

FIG. 2 shows the semi-ellipse or half oval, the most beautiful of all curves. It is in constant use among carpenters, joiners, masons, and gardeners. The Elliptic Trammel is the instrument usually employed for producing it. Sometimes it is made by a straight edge, or even a string and two pins; either method being equally correct. But, for face moulds, when both edges are elliptic curves, the string is generally preferred, because the quickest and most practical.

The long diameter A B is called *major axis*, and the short diameter D F the *minor axis*. As this figure has to be repeatedly referred to in all the hand-rail construction, we may drop the terms *major* and *minor axes*, and use instead *long* and *short* diameters.

To strike the curve, take any distance for long diameter, say A B; divide it into two equal parts, which gives D. Square up from D. Assume, say D F, for short diameter. Next set the dividers to A D. With that distance in dividers take F for centre and intersect long diameter, which gives C E as points to insert pins. This done, tie a string to pin C. Bring it around that in E. Now stretch the string with a pencil until its point touches F. Then sweep the curve towards A. Return to F, and complete it to B.

Remember not to use a chalk-line for this operation; that being generally composed of cotton, which is not to be depended on, owing to its stretching. Have the string of such material as stretches the least. Fine twine, such as is used for nets, or fishing-line, answers very well. Let the pencil have a notch near its point, in order to keep the string from slipping. Should there be any one not acquainted with this very simple mode of drawing elliptic curves, let it be learned at once. The operation takes but a few minutes. The materials are always at hand. Two pins, a linen thread, and a pencil, struck every mould laid down in this book. Try it on a piece of board, paper, or anything most handy. Should the first attempt fail, try again and again, until perfection is attained. Take care to keep the hand and pencil steady, and the string gently stretched, so as to produce the curve with neatness and accuracy.

The method just given for drawing the curve and finding points to insert pins has been adhered to in striking all the moulds presented in these pages. Therefore it will not be necessary to repeat the operation. Observe, however, that the rule is not confined to face moulds alone, but to all elliptic curves, the process being so perfectly simple that scarcely any one can fail to understand it.

To find the tangent for any part of the curve, say H, join H C and H E. Let H K equal H E. Draw K L parallel with H E, and of equal length to the last-named letters. Then draw from L, through H, thus producing the tangent. The value of this in hand-railing is of no great moment, for this reason, the tangents are first given, then

an elliptic curve being drawn, it touches tangents precisely in the centre of each *joint*. Still, the problem is useful in many other parts of joinery. It may be applied to elliptical stairs, in defining the position of joints on the ground-plan, but nothing more.

FIG. 3 shows the OCTAGON. This figure is often required in stair-building. Various methods have been given for forming it. Perhaps one of the neatest is to have a templet made to an angle of forty-five degrees, or, in other words, a piece of thin board, two sides of which forming a right angle and being equal, as A B C, join A C. This is a mitre. You are now ready to draw the figure to any size. Say its square shall equal C B. Then make C D equal C B. Now, place your square against the edge of drawing-board; reverse the templet, keeping its long side against the edge of square, and draw D E. Move the templet along the square, and draw E K. Move again, and draw B L. Return to C and draw C K. Square over from D, E, and K. Then square up C H. Apply the templet, as before, and complete the figure by drawing H F.

FIG. 4 shows a square, which is to be formed into an octagon. The best and most practical method is to draw a line connecting corners A and B. Make A D equal to one side of the square. Next, set a gauge from C to D. Run the gauge-line on all sides, which gives the direction by which to take off corner C E. Take off the other corners in like manner, and the octagon is formed.

FIG. 5 shows a figure of seven sides. This is not often used in stair-building; but it will serve to solve one or two other problems that may be useful.

Commence by drawing any line, say B C. Now, assume A B for one side of the figure. Draw the semicircle. Continue it past C as shown. Let B L equal B A. Draw from L to the left, touching the circle. Next draw from A through intersection, cutting at F. Then F L gives the stretchout for half the semicircle. The other half is obtained by making F H equal to F L. The semicircle is now to be divided into seven parts. This is readily done without making repeated trials. For example: Lay your rule down; keep its end on H, as a centre. Move the rule until it measures from H to K, say $3\frac{1}{2}$ inches. This makes seven divisions of half inch each, as P K shows. Drop a perpendicular from P, cutting at N. Then take N L in the dividers, and space off the semicircle into seven parts; being the number required. Next, draw from A through one of the divisions at E. This, to be correct, must equal A B. Now draw from E to the left, cutting line from A at D. Join B D. Set the dividers to A B; and, with that distance, from E and D intersect the remainder of lines through divisions of circle. Thus giving a figure of seven sides. It also illustrates the stretchout and a method by which the circle is divided into equal or unequal parts, without repeated trials.

FIG. 6 shows a method of *bending risers*, either concave or convex. For example: Make two plough-grooves, as shown. Kerf the face. Have two ribs made to the required curve. Force these gently into the grooves. Glue the edges at the same time. It would be well to bore a few pieces of the solid wood between the kerfs. Then fasten the ribs, with finishing nails, from both edges of riser.

The scotia, or hollow, had better be in the solid, and project, in order to give the opportunity of screwing it to the step. It would also be well to have a couple of dowels let into both step and riser. This regulates the curves at once, and saves trouble.

Work the nosing on step before fastening it to the riser. Put both together with hand-screws. Let all remain until the glue is dry. Then finish the scotia.

FIG. 7. It frequently happens at the cylinders of platform-stairs, that the face of riser has to be concave. The best way to do this is to run a gauge-line on both its edges, to the thickness of a veneer. Then slit the riser. Have the block A ready to the required curve. Also a piece made to fit the hollow. Slip the block A between the straight part of riser and veneer, as shown. Lay on the piece made to fit the hollow. Fasten with hand-screws. Let the work remain until the glue dries.

FIG. 8. The front of riser, starting from the floor, or at platform, is usually made convex. As a general rule, the thickness of riser is sufficient to have the curve in the solid. But, should it not, there is no objection to glue on a piece, as shown. The joint will not be noticed unless the riser is hard wood. In that case have it veneered.

PLATE 2.

THE TANGENT, BEVEL, AND ELLIPTIC CURVE.

THE solution of this problem will fully illustrate the method by which the bevel, ordinate, and pitch of plank are obtained. It will show *hand-rail construction* reduced to a very narrow compass; making it accessible to all who may wish to learn and practise this art. But to ensure perfect success, and have a clear perception of the meaning and intention of every point, the drawing had better be made on card-paper, which can be cut in such manner as to show the surface of plank, and its pitches when standing in position over the ground-plan.

The most simple form of wreath is that which makes equal pitches; and has both tangents to elliptic curves the same length. To explain this, let Fig. 1 be a square of any size. Draw the quarter-circle. This shows that A, B, and C, are tangents. It is now required to have the plank make two equal pitches, of any inclination, to stand on A B and B C. These pitches are indicated by A D and E F, which make C F equal to the height of both.

The ordinate in this, and similar cases, will always be the diagonal of a square, as shown. Let the lines from A and C be drawn parallel with it. Make the seat square with it. Have the height K L equal that of C F. Join L H.

This is the pitch of plank; it is likewise long diameter of elliptic curve.

Square over from L O H. Make L C equal K C; and O B equal diagonal of square below the seat. Have H A equal corresponding letters from seat to corners of square. Join A B and B C. These are tangents to elliptic curve which, to be correct, must equal the pitches A D and E F, at Fig. 1.

The next consideration is to find half the long diameter of elliptic curve. This is obtained by continuing quarter-circle to cut the seat at N. Draw from N to cut the pitch at P. This gives P O as half the length. Set off the other half from O, on the left, to equal it. Make O R equal one side of square below. Next, find points to insert pins. This done sweep the curve with a string. It touches, as you observe, the points A and C which correspond with quarter-circle below, touching similar letters. This shows correct and accurate work.

Now, suppose a piece of board laid on Fig. 2, its square edge being fair with L H, and the tangents A B and B C marked on it. These have to be cut and bevelled so that the edges A B C of board shall be plumb when standing in position over A B C of Fig. 1. It would be impossible to do this without a bevel, which must be obtained and applied in the most accurate manner. The least error in this matter destroys everything, and renders all that has been previously done of no value. Such is the importance of a bevel.

Two methods are here given to obtain it. The first is shown on the left of Fig. 1. For example: Take B for centre, and for radius a circle touching line A D, cutting 2. Join 2 A, and the angle thus made gives the bevel. Its application is—to have the stock on surface of board square with edge, which is to be bevelled. Work according to bevel. Then the edges of board, when in position, will stand plumb over ground-plan. Here it may be stated that the method just given for finding a bevel is limited to tangents which form a right angle on ground-plan. Then the pitches of wreath must be equal; as is the case here.

The second method is shown above, Fig. 2. This can be applied to all and every position, no matter how the tangents are situated, or in what form the wreath may be, its application is certain and reliable. It is obtained by drawing a line from B parallel with pitch H L. And again from B a line parallel with ordinate. Assume any point on this line, say V. Square up to cut at E. Now, take V for centre, and for radius a circle touching tangent B C, and cutting at S. Join S E, and we have a bevel the same as that given at Fig. 1; and yet there is no similarity in the construction.

The drawing is now complete. It is supposed to be made on card-paper, which, being cut in the following

manner, will give a correct idea of the surface of plank and its pitches. Commence at Fig. 1, by cutting through height C F. Then through F E. Continue in like manner to B. Also cut through B D E. Then slightly cut under-side of paper, on lines A B and B C. The paper now works as if hinged on the two tangent lines. Turn it up until D and E come together. This forms a right angle, or two sides of a block having equal pitches. Now proceed to Fig. 2, and cut through height K L. Then through L C and H A. Continue in like manner through A B and B C. Next, slightly cut under-side of paper on line L H. This forms a hinge. Now turn the paper up. Let A B C rest on the pitches of Fig. 1. It will be seen that, in this position, the edge of plank H L stands over the seat and is perfectly square; while tangents A B C, Fig. 2, not being parallel with long diameter H L, show that edge of plank on these lines must be bevelled in order to stand plumb over tangents on Fig. 1. This explains the necessity and importance of having a correct bevel for the joints of a wreath.

The elliptic curve and bevel may be shown in a different manner, by simply having the pitch H L. For example, extend B O to cut height at 3. Now turn to Fig. 3 below. Here the letters, on long diameter and tangents, correspond with those of Fig. 2. The dotted line O 3 equals that above. It gives a direction to draw 3 L.

To find half the long diameter of elliptic curve: Draw from O square with 3 L; then make O V equal to O R; this done, draw from V. Square with V O, cutting P, which gives P O as half long diameter. Make other half on the left equal it. Find points to insert pins; this being done, strike the curve with a string.

To obtain the bevel. Draw from C, parallel with L O. Again, from C draw parallel with L 3. Now assume any point on line from C, say N. Square down from it to cut D. Then take N for centre, and for radius a circle touching tangent B C, and cutting at E. Join E D, and we have a bevel that is equal and makes the same angle as those given at Figs. 1 and 2. This completes the drawing.

FIG. 4 is a problem in joinery. The object of giving it in connection with hand-railing is, to show the similarity of obtaining bevels for work, which cannot be correctly done without their use. Take, for example, a hopper, its sides standing on any required slant, the corners mitred, and when together forming a right angle, the edge of stuff to be square. Commence by drawing any line for a base, say A C, square up from each letter. Assume any slant, say A B. This makes the perpendicular height C B.

To find a bevel to cut the side. Take A for centre, and B for radius. Draw the circle cutting at D. Join D C. Then the angle A C D contains bevel on the right for cutting the sides. Now find a bevel that will give the mitre for edge of stuff. This is obtained by making C E equal C A. Then take C for centre, and for radius a circle touching slant, and cutting 2. Join 2 E, which gives bevel on the left, to mitre edge of stuff.

FIG. 5 shows two of the sides spread out, forming the right angle J K L. The mitre being K D. Now, let both sides be raised until mitre closes. Then it will be found that the height equals that of C B below. This problem may be quickly and practically illustrated by making one cut through a piece of board, as the bevels direct. This cut being made, reverse the edges, and bring both pieces together, and we have the practical solution of a very useful problem.

It certainly must be admitted that the manner in which these bevels have been obtained and applied differs very little, if any, from method given at Fig. 1.

And here it may be mentioned that joinery has many parts requiring a constructive principle which will equal and compare with anything known in stair-building. This will be clearly shown in a *forthcoming work*.

The subjects of Bevels, Tangents, and the Ordinate, will be continued on Plate 5.

Plate 3.

Fig. 1.

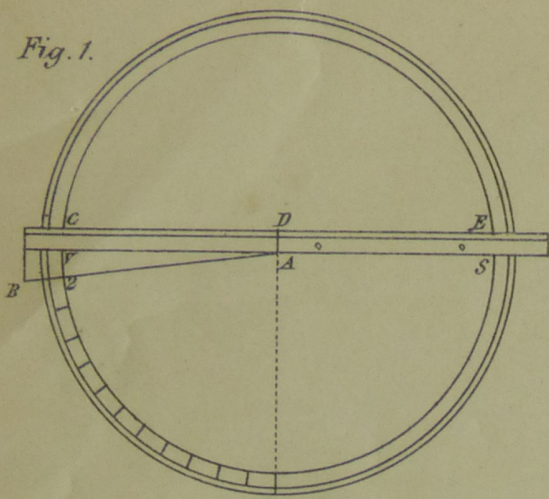


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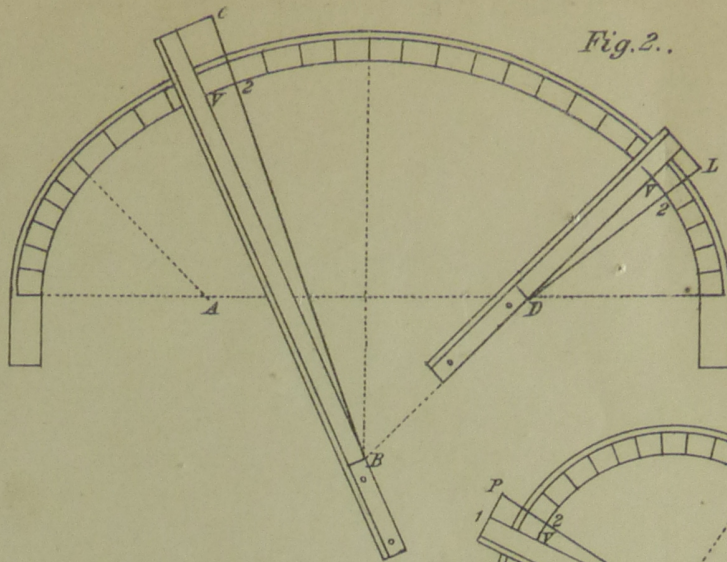


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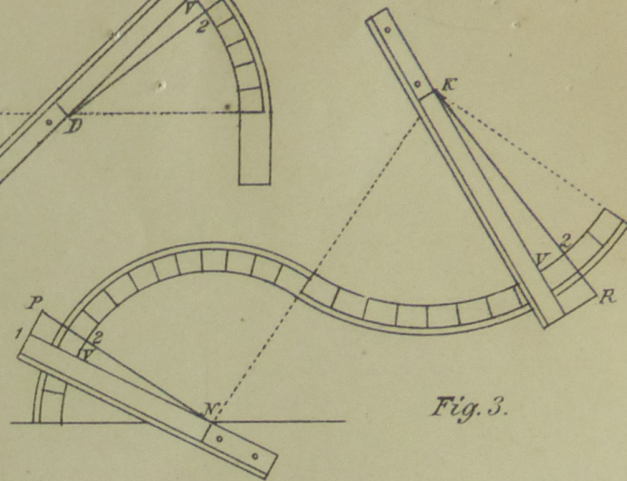


Fig. 4.

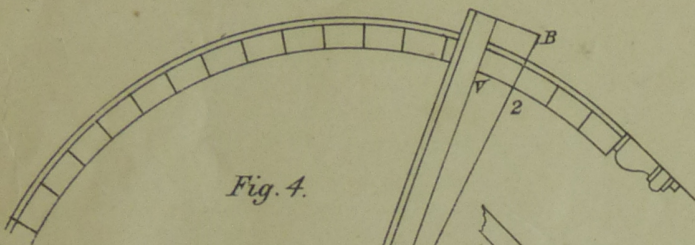


Fig. 5.

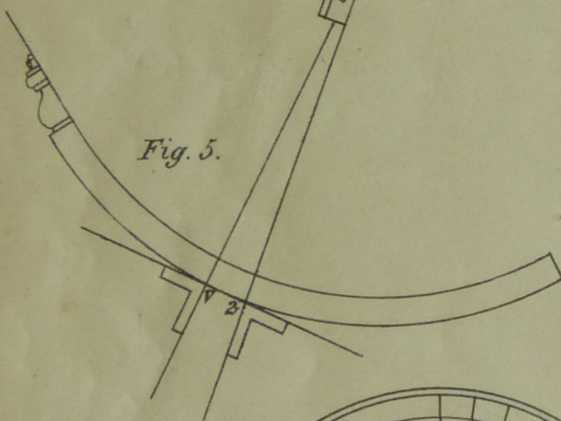


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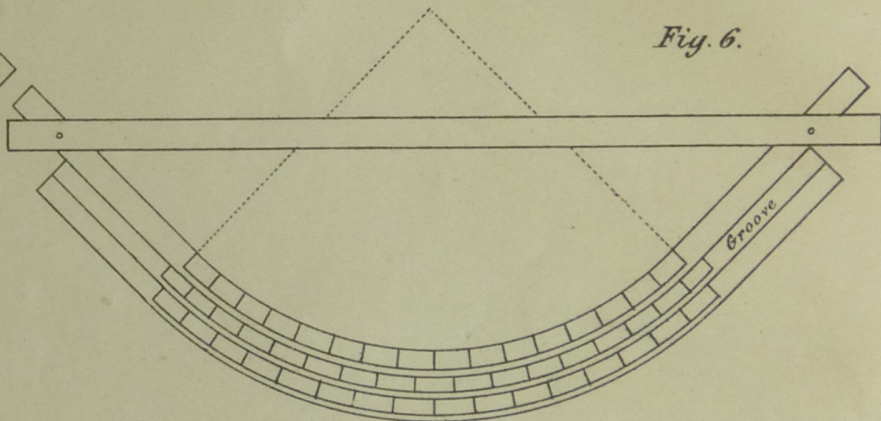


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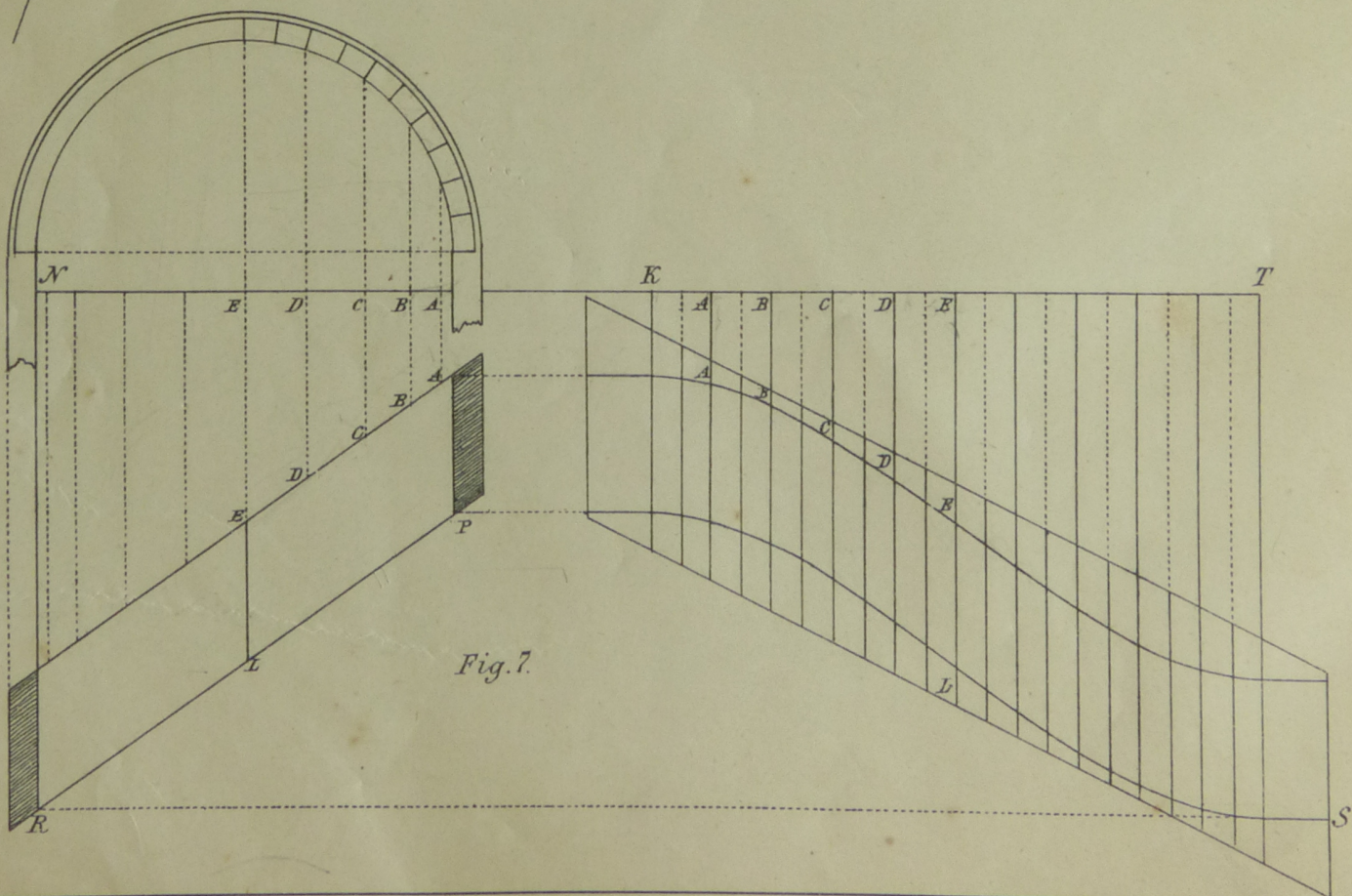


PLATE 3.

KERFING—ITS APPLICATION TO BENDING MOULDINGS, SOFFITS, FRAMING, AND CIRCULAR STRINGS.

* THE method of kerfing which I published in the CARPENTER AND JOINER has been thoroughly tested, and approved. The principle is simple, correct, and reliable.

Let the saw be properly filed so as to make a clean cut, leaving no ragged marks on the surface of the work. The saw should have a fence to stop the kerf at the proper depth. The success or failure depends on the manner the cuts are made. If careless and slovenly, both time and material are lost; if neatly and accurately, the work will bend to the required curve, and be equal, (some think superior) to having it in the solid.

Fig. 1. Let C F be the diameter of a cylinder which is to have a band bent around it—say three or four inches wide, and an inch thick. The following method will show the solid wood between the kerfs:

Take a strip, of the same thickness as the band; run a gauge on so as to leave a veneer. Then make a cut down to the gauge line. Lay the strip on; keep the cut opposite centre A. Fasten the end to the right with a couple of nails. This done, lay a straight edge against O D; push gently until the cut closes. The strip having moved from A V to A B, gives V 2 as the solid wood between the kerfs.

This easy and practical operation being the whole secret of kerfing, one or two points are to be remembered. For example: the cut in the strip, and the kerf in the work, must be made with the same saw. Again: the band of the quarter circle is reduced by kerfing; consequently, the number of these kerfs must be added to the stretch out of the quarter circle.

To make this more clear—take twelve blocks that equal V 2, and stand them around the curve as shown. Now, open the joints to equal the kerfs; this causes the two extreme blocks to extend beyond the limits of the quarter circle, and to show a quantity of solid wood which must be equal to the kerfs. Therefore, when great nicety is required to have the bent work stand over the plan, it will be best to lay out a piece of solid wood; then make a kerf; proceeding in this manner until the number of pieces contained in the circle is complete.

Fig. 2 shows the elliptic head struck from three centres, A, B, D. This is kerfed by the same method as Fig. 1, the solid wood being indicated by V 2. In all cases the strip that gives the kerfing must be the same thickness as the stuff which is to be bent.

Fig. 3 exhibits a double curve, the solid wood between the kerfs indicated by V 2. Let the veneers be on opposite edges of each curve. The centres are at N and K.

Fig. 4. To bend a moulding inch thick around a curve struck from centre A.

Take a strip, same thickness, and run a gauge line so as to leave a veneer. Make a cut, down to the line; lay the strip on, and fasten it below A. Now move it until the cut closes. This being done the face of the strip stands on the line A B, and gives V 2 as the solid wood that remains between the kerfs.

Adopt this method for any kind of work that is to be bent.

Fig. 5. Here the moulding is on the convex curve,

which makes kerfing rather difficult, especially if the moulding is large. The bending may be done by cutting the moulding into thin strips. This, however, is objectionable, not only on account of time, but it reduces the moulding by cutting.

The best method is to make two cuts in a mitre-box, according to the bevel shown. Cut the mouldings into short lengths, say V 2. Call this blocking. Bore through the end of each piece, and fasten with brads. Let this boring be done before the piece is cut off, to avoid splitting. It would be well to use a little white lead in the joints. Clean off with coarse sand-paper, and finish with fine. If the job is neatly handled, the moulding will appear as if worked in the solid wood, and equally good.

Fig. 6. Here we come to circular framing, where kerfing can be employed to great advantage. The plan may be a quarter circle, or any curve, upon which the work stands. Let the stuff be in three pieces, and sufficiently wide to make the top and bottom rail. Have the centre piece one inch narrower, so as to form a groove for the panel. Bend the concave piece, first fastening it by a brace on both edges. Have glue ready, and lay on the piece that forms the groove; then lay the convex piece. Fasten with hand-screws, and let the work stand. When perfectly dry, cut it so as to form the top and bottom rail, shown on the left.

Fig. 7 shows a circular head standing on the skew. The door-jambs R P, being on a line with the front of the building. A board is now to be bent to form the semicircular head. Proceed to find the kerfs by the method just given. The quarter circle shows half their number; this is sufficient to obtain the curves to be made on both edges of the board. Draw a base line, say N K T. Make R S parallel to it. Drop perpendiculars from every other kerf in the quarter circle, cutting the skew line A E. Set off the same number of parts on the base line toward N.

We have now a direction to find the curves on the edges of the board. Observe that the kerfing shows ten pieces of solid wood (kerfs not included).

This understood, take any point on the base line, say K, and set off twenty divisions, each equal to a piece of solid wood in the quarter circle. Now transfer A A on the left to the right of K. Then B B, and C C, and so on to E E. Thus giving points to trace one-half the curve. Obtain the other half in same manner. Let both edges of the board opposite E L be square, and the edges standing on the lines K and T, bevelled to suit the jambs R P. Then the board being kerfed and bent to the semicircle, and standing in position, its edges will be on a straight line, and fair with the front of the building.

This teaches a lesson in stair-building. Imagine the semicircle half a cylinder, and cut on the line R P. Then the circular head we have just bent will cover it, and the cut on the cylinder and edge of the board will be fair. Now look at the board spread out with its curved edges, and the pitch line from K representing a plank for a wreath. The curved line from A to E shows the form of half the wreath landing on a level floor. Also the thickness of stuff required to make it.

PLATE 4.

TO LAY OUT THE WINDERS FOR QUARTER-CIRCLE STAIRS—THE WALL-STRING BENT BY KERFING.

FIGURE 1. Commence with the right angle B K F. Take B for centre and draw face of cylinder, also the wall string. Determine width on narrow end of winders, say $5\frac{1}{2}$ inches. Let V N be the face of first riser starting. Fix on number of winders, say six. Let V 2 measure $5\frac{1}{2}$ inches. Set off, from 2 on the circle, five spaces to equal V 2. Square over D E. Next divide E N into six equal parts. Draw face of risers. This completes the position of winders on the plan.

The centre of Newel stands on A.

The next consideration is the circular wall-string which is bent by kerfing; a much better method than the usual way of bending it over cylinders or forms. Besides the work is done in less than half the time.

The first operation is to find the stretch out from K to F. Take B and K for radius, also centres. Make the intersection at P, continue the circle to O. Square over O R. Let P S equal O R. Then S K equals the circle K F. Perhaps a more practical way is—have a pattern to the curve. Mark one of the winders on it; also H F and K L. Then lay out the string by rolling the pattern, by which means you are unfolding the curve.

Fig. 2 shows the string laid out and cut in for steps and risers before bending.

The line T F is the stretch out. Lay off the spaces to equal X Y on the circle. Make a pattern, of

parallel width, to equal X Y, the solid wood between the kerfs. Begin at the middle of the stretch out. Make a cut. Mark with pattern on each side of it. So continue, right and left, until the required number of spaces given to T and F are complete. The string will now bend between the quarter-circle and all the cuts close. The piece of solid wood beyond each spring-line is equal to half the number of kerfs. In other words, the last cut will pass the spring-lines showing more or less solid wood, according to thickness of the saw. The letters H, F, E, on the upper end, correspond with those on plan and show the position of risers on the string. Then K L, on the lower end, also agrees with K L on plan. Some workmen build the stairs in the shop; in which case the string is ready when kerfed. Others prefer to fix the strings and carriages in the building, in which case, the circular wall-string is bent and secured with a brace. But, if the finish be walnut, oak, or other wood, have a veneer of the same. Lay out steps and risers; prick through for those of the kerfed string, which cut; avoiding those on the veneer until bent and glued.

Fig. 3. SPLICING. Stuff can seldom be obtained sufficiently long to have the string reach from story to story. It has to be made in two pieces by splicing, and there is no better way than here shown; it being a long splice, the joint glued. Lay on a couple of strips, fasten with screws, removing the upper one when the string is fixed.

Plate 4.

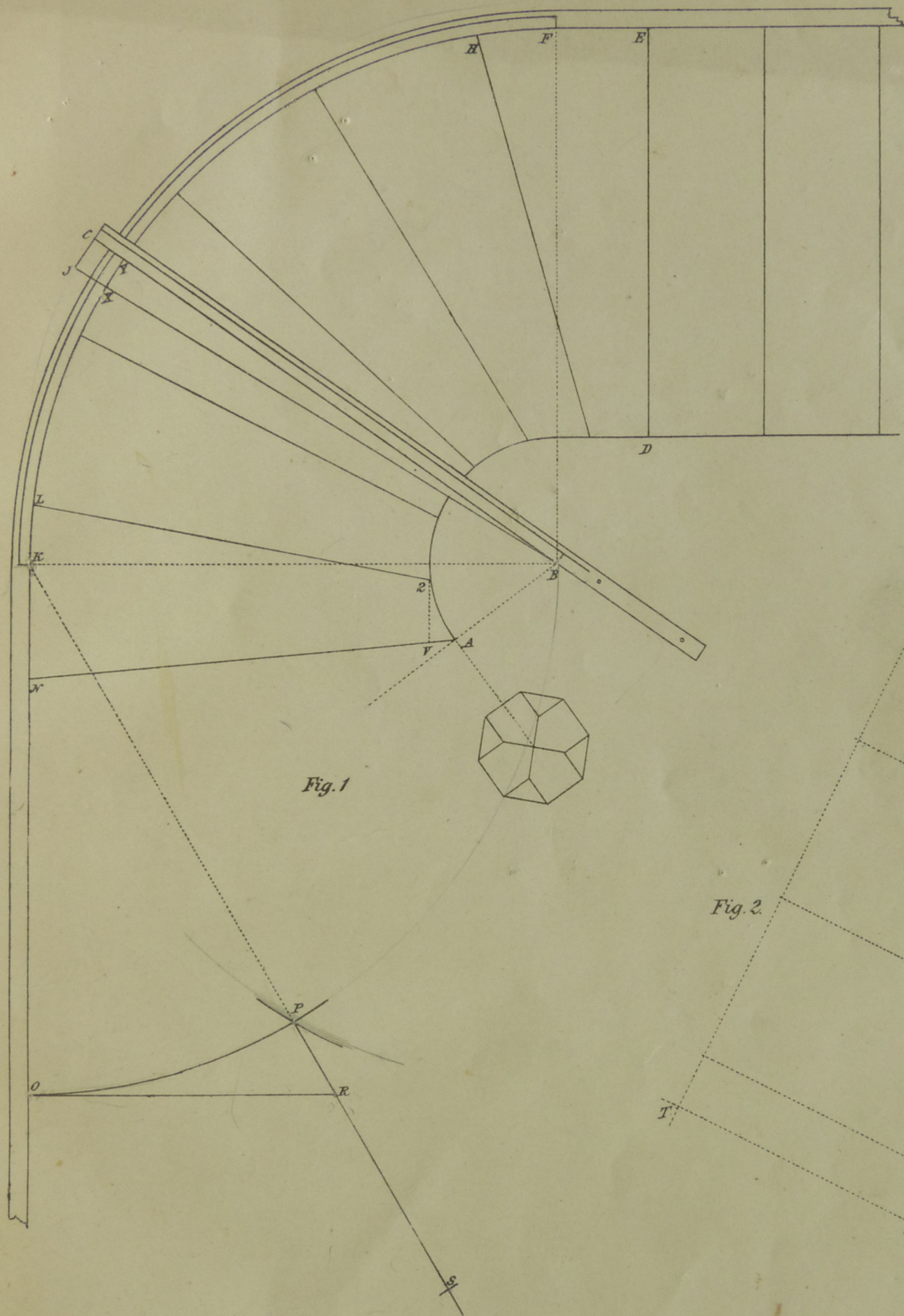


Fig. 2.

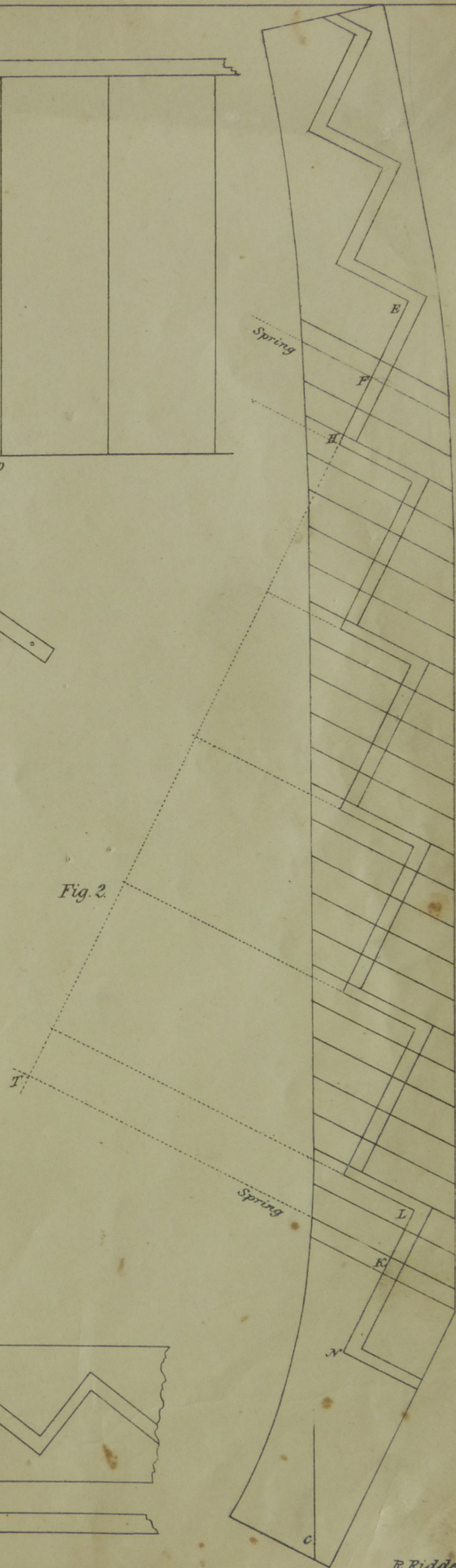
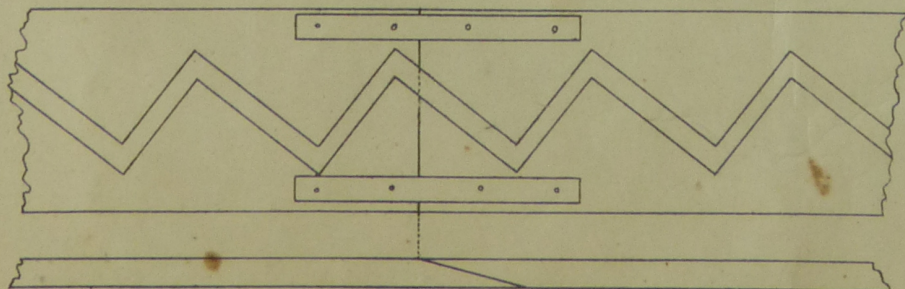


Fig. 3.



Scale: one inch.

E. Riddell

Plate 5.

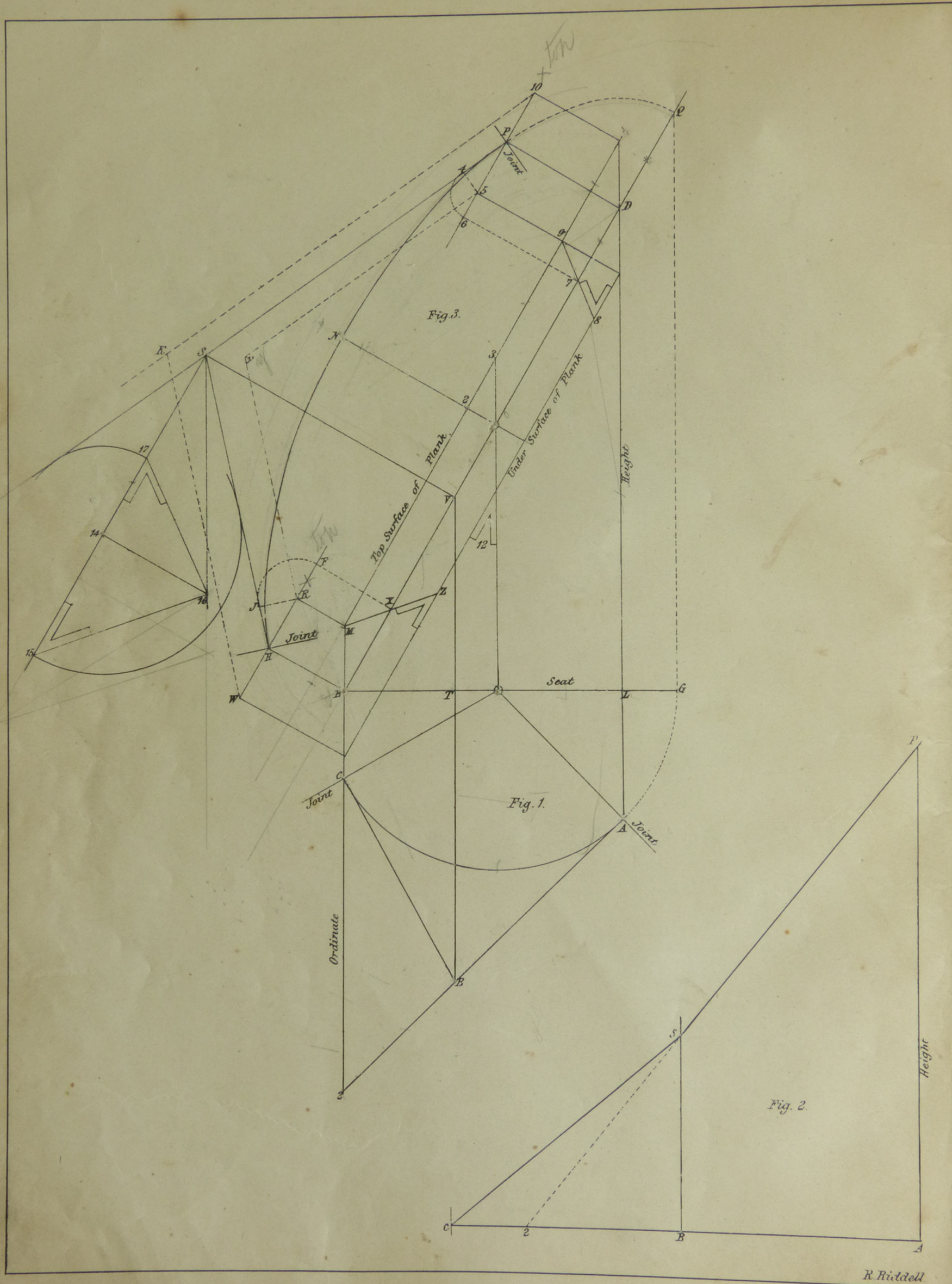


PLATE 5.

THE ORDINATE, ITS POWER AND VALUE IN THE CONSTRUCTION OF WREATHS.

FIGURE 1 shows a problem, the solution of which explains all that is really requisite for the complete understanding of hand-rail construction. Let the learner who wishes to be a master of the art, carefully examine the meaning and intention of each line. By so doing, he will be instructed, and know all that is possible to be known or can be acquired.

The diagram here presented is of such importance, that to pass it over lightly, or without thought, is to make the drawings which follow of no avail, and quite unintelligible. It is certainly true, that a wreath may be produced by imitating what is shown on the paper; but that is not learning. Parrots can talk, not knowing the meaning of words, being incapable of further progress. Many will dream out an idea, and trust to luck for the result. Such indifference to the attainment of correct knowledge is one cause of our having so many incompetent and unskilled workmen. These are facts that cannot be disputed or questioned. Therefore, let the learner commence with a determination to master this one problem. It is the key to all that follow, as will be clearly shown by the examination of a single line called *Ordinate*. It is this which produces with certainty the exact angle of tangents for any portion of a cylinder. It determines the only reliable method of finding bevels for joints. It throws the plank on any two desired pitches, so as to form either ramp or easing. In a word, it defines and regulates every part of the construction. Such is the power of a single line, when properly placed. To test this matter in a plain and practical way, commence by drawing any portion of a circle, less or more than a quarter. Figure 1 conveys the idea. Draw the tangents A B C. It is now required to show the form of a wreath having two unequal pitches, which shall stand correctly over the plan just made.

FIG. 2 (below to the right) shows the tangents of ground-plan unfolded, or spread out as A B C. Square up a line from A and B. Assume any height, say A P, and for pitch of upper tangent P S; extend it to cut at 2; join S C. This gives the lower pitch. Here understand that the lines which have just been made are not the pitch of plank, but tangents on its surface.

Now pass to Figure 1, and extend tangent A B. Then make B 2 equal to that of B 2 below. Draw from 2 through C. This gives ordinate. Again draw B and A parallel with it. Make the seat square with it. Let height L D equal that of A P, Figure 2. Join D E. This is the pitch of plank; likewise long diameter of elliptic curve. Let lines be squared over to the left from D V E and O. Now make D P equal L A, and V S equal T B. Also E H equal E C. Join H S and S P. These are tangents to elliptic curve; and, to be correct, must equal the pitches shown at Figure 2.

We now come to bevels for joints. This important matter must be distinctly and clearly understood, as no wreath can be properly produced unless bevels are correctly obtained and applied. In the first place, we shall notice what is termed *Sliding the Mould*, it being moved a certain distance on both surfaces of plank, undoubtedly gives direction to mark a line on joints which is equivalent to a bevel. The conditions are: the plank has to be made to an exact thickness. For the least error in the movement of the mould gives a wrong direction to mark the joint.

To explain this point: Take any distance for half thickness of plank and set it off on each side of pitch D E. Now, the top and under surfaces are seen. Here the bevel 12 cuts top surface at 3, giving 2, 3 as distance to slide the mould. This understood, draw through joint P, on the right, and H, on the left. These lines are parallel with pitch D E. Let H R and P 5 equal 2, 3. Now move H to stand opposite R. This has caused solid lines H S and S P to stand over Y R and K 10. Then R and 10 are points on top surface of plank. Return to H; make it stand opposite W. This movement has made H S to fall on W K, and S P on 5 Y; consequently, W and 5 are points on under surface of plank. So that lines being drawn on each joint of wreath, as R W and P 10 direct, would unquestionably stand plumb when the wreath is in position. Or, more properly speaking, range with plumb-lines, as all joints are made at right angles to surface of plank and square with tangents on it. This operation shows that bevels can be dispensed with; but the process is tedious and uncertain; and, worse still, it has neither intelligence nor design. Yet it gives the opportunity of showing bevels on edge of plank, which will serve to illustrate a still more correct method, and one of the most

important discoveries that has ever been made in hand-railing. To illustrate this: Commence at joint H, on the left, and square up from R to cut at J. Make R F equal R J. Then from F square down to cut centre of plank at X. Draw from M, through X, which gives bevel Z for joint H. This is evidently correct. Now proceed to joint P, on the right. Let 5, 6 equal 5, 4. Square down to cut 7. Draw from 9 through 7, cutting 8, and we have the bevel for joint P. Here it is easy to see the reason why this bevel makes a less angle than that of Z, on the left; because joint P is farther removed from long diameter. Again: suppose P stationary and joint H brought down to E. Then bevel 12 would apply instead of Z. This shows that the angle of bevels depends upon the situation of tangents.

We will now give the only correct and reliable method for bevels, as seen on the left. Extend tangent P S. Draw S 15 parallel with long diameter. Next draw S 16 parallel with ordinate at Figure 1. Now assume any point on line S 15, say 14. Square down to cut line from S at 16. Take 14 for centre, and for radius a circle touching extended tangent P S, cutting at 17. Join this and 16. The angle thus obtained contains the bevel for joint P, on the right, and is equal to that of 8, 9, shown on edge of plank.

Again: take same centre, and for radius a circle touching tangent S H, cutting at 15. Join this and 16, giving the angle containing bevel of joint H; it being equal to that shown at Z. This process of obtaining bevels is simple, yet perfect in construction, and its application to joints will always be found correct in every particular.

It has been stated that sliding the mould a certain distance, with other conditions, gives a plumb line on joints which is equivalent to using a bevel. This is quite true, as the bevels on the left make exactly the same angle as those shown on edge of plank. Yet there is a wide difference in the methods. One is that of unerring certainty, whilst the other depends on what might be called "chance."

To illustrate this: Take two pieces of wreaths, squared and bolted together. Let the same stand in position over the ground plan. Now, if there is the least error in what should be plumb-lines on the joints, it throws everything wrong.

It will not do to say, "slacken the screws, and twist the pieces to make them answer." That would be impossible, as there must be no tampering with joints when once together; for, by so doing, the pitches are changed, which renders work and material useless, and, of course, the wreath has to be cast aside. Here we see the importance of having correct bevels, and the necessity of adopting a reliable method. Such has been given and fully explained.

The lines for obtaining these bevels may be situated in various positions, and still the same results be produced. One line must always be parallel with ordinate; and the other parallel with long diameter, as here shown. The tangents combine with these, and make the construction perfect. It is not necessary to enlarge on this matter, as the drawing is sufficiently clear to show both cause and effect. Those who investigate it thoroughly and comprehend its meaning, will never have any difficulty in the proper construction of hand-rail wreaths.

To find half the long diameter of elliptic curve, continue the circle at Figure 1 to cut the seat at G. Draw from G, square with seat, to cut at Q. Then Q O is half of long diameter; and for short, let O N equal O C, Figure 1. It will be remembered that the short diameter, when standing over its plan, falls perfectly level. It is always equal to half the diameter of circle on ground-plan. Again: the edge of plank, when in position, must always range, or be out of wind, with the seat. Such being the case, then the short diameter of elliptic curve falling level, shows that the edge of plank, in all situations, must be exactly square.

These facts are mentioned to assist the learner; for it has been thought, and even published, that in order to produce a wreath the plank has to be thrown in a certain position, with its edge bevelled. This is not correct; for the ordinate clearly shows the proper direction of plank, and its position on plan, which makes the surface and edge a right angle in all situations. This will be illustrated still further, as we proceed to examine the more practical drawings, all of which will be readily understood if the learner has made himself thoroughly conversant with the problem before him.

PLATE 6.

TO LAY OUT STRAIGHT STAIRS, HAVING CYLINDER AND WREATH TO LAND ON LEVEL FLOOR.

NOTHING can be more simple than the construction of a plain flight of straight stairs having the risers and string mitred. The rail starts from a newel and lands with a wreath. The work may be done by any good joiner, there being no part of it difficult. The only point on ground-plan that requires attention is to fix the last riser-landing in such a position as to make the level part of wreath stand a proper height above the floor. It is usual to make long balusters on square steps answer for level rail on floor. The method of fixing position of last riser-landing will apply to all sizes of cylinders, as the drawing explains. Let, for example,

Fig. 1 be the ground-plan, and draw a line through the centre of rail, to represent floor, as shown. This done, set off a step and riser; then draw centre of long baluster, cutting at N. Next set off half width of rail on each side of S to the left. Return to N and draw level rail-cutting through the width on the left. This gives 2 H, as points to draw pitch of plank; its thickness and width of rail being usually the same. Next set off thickness of rail from top side of plank; this drawn to cut at R. Now take S for centre, and R for radius, and draw circle cutting at P. Then square over from P to the left, and we have position of riser-landing.

It is evident it would not answer to have the riser at any other place but just where it is; as the height of level rail has already been fixed. Now draw a line from centre T, cutting pitch of plank at B. This gives A B as half of long diameter of elliptic curve; and A 2 for half width of mould at joint.

Fig. 2 shows the rake-mould drawn on a piece of board, ready to cut. Distance A B equals that of pitch above. Let A V equal T V on plan. Set off half width of rail on each side of H. Then draw straight shank. Next, set off wide end of mould at A to equal that shown on pitch above. This done, find points to insert pins. Then sweep elliptic curves with a string. The mould being ready, lay it on the plank. Mark along edges of mould and have the plank cut square through. Let the top side be out of wind. Work the edge for straight shank square with surface of plank. This done, square over edge from P. Mark half the thickness of stuff. Next take bevel B from angle above, apply it to edge of plank and draw P P. This is the pitch of wreath-piece. Now lay mould on. Keep P on it opposite to P P on edge. Mark surface of plank. This done, apply, in like manner, to the under side. Take off the slabs according to lines made by mould on both surfaces.

Observe, when working, to hold the plane in the same direction as line P P on edge of plank. The piece has now its cylinder form.

The next operation is to cut off slab L square with joint. This done, it will be seen that the

corner on concave side gives a perfect direction to form the easing from rake to level. Nothing further remains but to gauge the thickness. The mould for bevel piece of wreath is simply a quarter-circle.

Let the stuff be of the same thickness as that of rail, as shown by square section on the left. It would be still better to have it say half inch thicker; which gives the opportunity of continuing easing past the joint, adding much to the appearance of the wreath. It would likewise be well to leave the stuff full at joint, and, after both pieces are bolted together, clean off to width and thickness. Observe, when fastening the joint, to keep line made by bevel L opposite a square line through joint B of level piece. This throws the wreath into its proper position; as may be proved by laying long side of pitch-board on straight shank, when the step of pitch-board and level part of wreath will be out of wind.

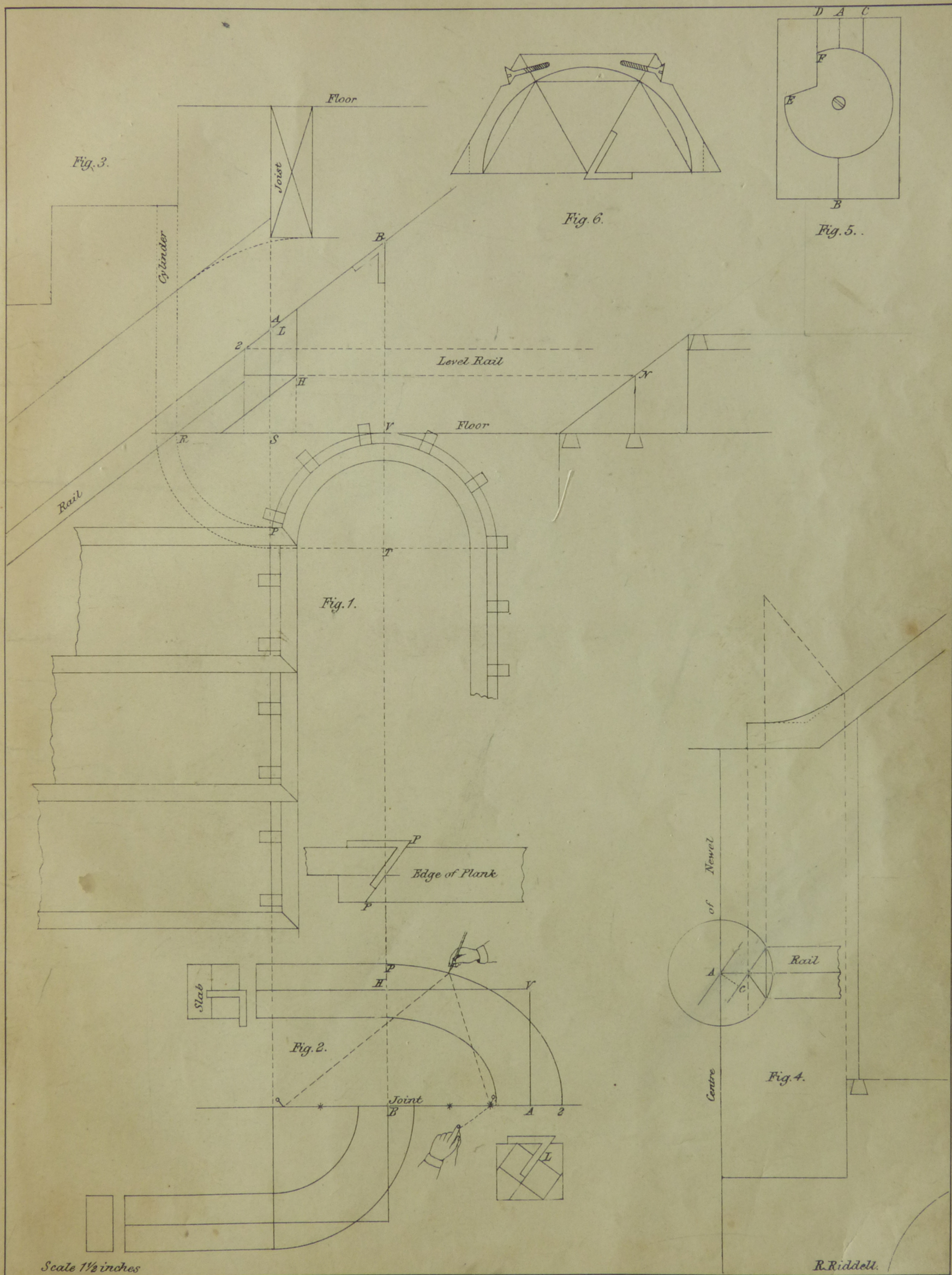
Fig. 3 shows position of strings, cylinder, and joist at the landing.

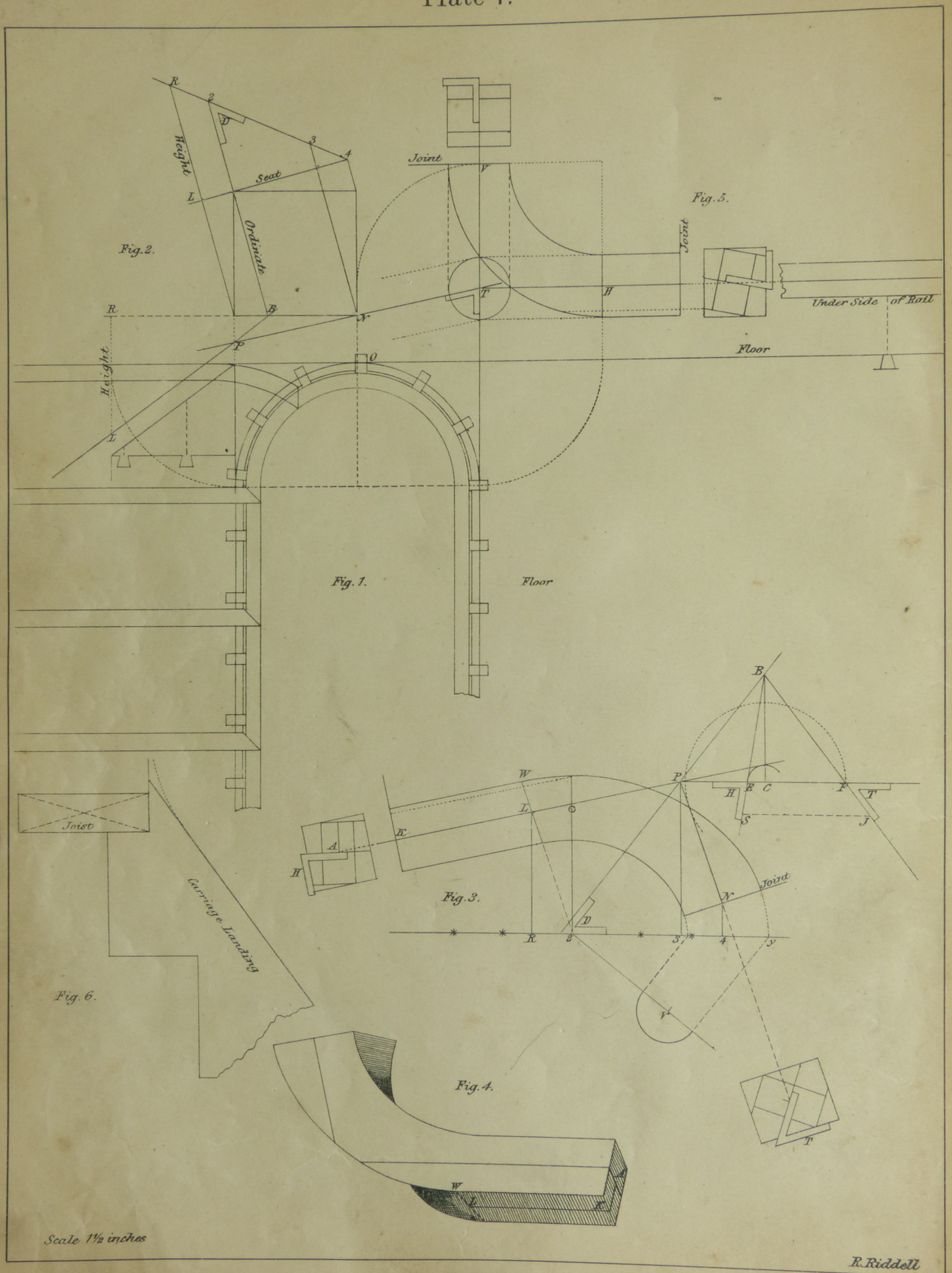
Fig. 4 shows mitre-cap, ramp of rail, and centre of newel, at the starting. This may be laid down on a narrow board, the width not exceeding that of square step. Continue face of riser to cut ramp. This gives the opportunity for measuring length of straight rail from cylinder to line just made on ramp. Or, the string gives it equally well. Either method answers.

To cut the mitre-cap at once, so as to fit given mitre on rail. Draw through centre A, parallel with one side of mitre; this gives distance A C. Now have a piece of plank, as shown at Fig. 5. Mark any line on its face, say A B. Let A C and A D equal A C, Fig. 4. Square over the end of piece, and make a cut, with panel-saw, through D and C. Keeping thickness of blade toward A. Now bore for a screw through centre line A B. Fasten the cap from its face, or from back of block, with a screw. Now enter the saw at D, and make one cut through F. This done, set the dividers to width of rail, and mark it on edge of cap from F, which gives E. Revolve the cap until point E stands opposite C. Enter saw at C, and cut through E. This completes the mitre.

Fig. 6 shows the cylinder. The staves may be worked in long lengths and afterward cut. Let the joints be glued and screwed. To neglect this precaution is to have bad work; for this reason. Wet mortar affects the wood, and, as it dries, the joints of cylinder open.

There is yet another point to be mentioned in relation to laying down the plan. The drawing should be made on a board of the least possible dimensions. Let everything be clearly and distinctly shown. Have nothing like confusion; for, by adopting *order* and *method*, the work will be done much quicker and better than otherwise.





Scale 1 1/2 inches

R. Riddell

PLATE 7.

CONSTRUCTION OF A WREATH TO LAND ON LEVEL FLOOR.—FIRST-CLASS STAIRS.

FIGURE 1 shows the ground-plan. The face of riser-landing is made to stand fair with a line through centre of baluster at O. This arrangement is much better than that given on preceding plate. Here the wreath will present a more finished and graceful appearance by having the riser-landing situated as shown. Let the line through O be extended to the right, in order to represent the floor. Enclose centre line of rail by tangents, which form two squares. Set off a step and riser, as shown on the left. Transfer distance given by long baluster to floor on the right. Then draw under side of level rail. Set off half its thickness. Draw this to cut at T. Now return to step on the left, and there set off half thickness of rail; which draw, cutting through P. Join P T. The lines just drawn are the pitches of plank. We must now find the direction of ordinate and height for lower part of wreath. Both are obtained by drawing from N to the left. This gives L R for height. Extend L P to cut at B. Now form a square the same as one below. Draw from B through corner of square. This is the ordinate. Draw from other three corners parallel with it. Make seat square with it. Let the height L R equal that given below. Join R 4. This gives the pitch of plank, and likewise long diameter of elliptic curve.

We are now ready to draw the mould on a piece of board, and find the bevels for lower part of wreath at the same time.

Fig. 3 shows the board. Draw any line for long diameter of elliptic curve, as R 2, 3, 4. These correspond with those at Fig. 2. Square over the lines. This being done, transfer distances from seat to corners of square. Fig. 2 to that of Fig. 3, as shown. Join N P and P L extended. The lines, to be correct, L N P must equal pitches above, having corresponding letters.

To find bevels for joints and width of mould, take bevel D, seen in the angle at Fig. 2, and apply it as shown at Fig. 3. It will be seen that the line cuts through the angle of tangents at P.

Again, from P draw a line to the right square with P 3. Assume any point on line just made, say C. Square up from it to cut at B. Take C for centre, and for radius a circle touching tangent P N cutting at F. Draw from B through F. This gives bevel T for joint N. Its application to joint is seen at square section below.

Take C once more for centre, and for radius a circle touching extended tangent L P, and cutting at E. Draw from B through E and we have bevel H for joint K on shank.

To find width of mould at both joints. Set off half the width of rail below C. Draw this to cut both bevels, which gives S E to set off on each side of K, and J F for each side of N. It is understood that joints on the mould are always made square with tangents.

To find half the long diameter of elliptic curves; let 2 O equal one side of square above. Set off on each side of O half the width of rail. Then draw from 2, square with bevel, D. Let 2 V equal 2 O. Set off, on each side of V, half the width of rail, and draw lines parallel with bevel D, cutting at Y and 3, which gives the wide end of elliptic curves. Next, find points to insert pins, and sweep the mould. *It is plain that nearly the whole of this construction is composed of right angles and parallels. Such will be the case with every mould, no matter what form the wreath may be.*

The next question is the application of moulds.

Let the stuff be cut square through, it being marked according to mould, and one side out of wind. Lay on the mould. Mark the joints and short diameter O 2. It would also be well to mark the tangents at the same time, which will give a better opportunity for having joints more correct, not depending on a line made by mould. Use a nine- or twelve-inch square; which must be perfectly true. Apply the stock to joint. Make surface of plank and blade agree.

Change position of square (still keeping its stock against the joint); make the blade and tangent agree.

If you would have correct work, be particular in making joints in the manner just stated.

The next operation is to set a gauge to half the thickness of stuff. This done, square over the tangent lines on each joint. Then run the gauge to intersect them. This gives a point through which the blade of bevel cuts. Mark square sections of rail, as shown. Take off the slab on shank (indicated by dotted line). Work it according to bevel H. Next, draw a line from A on joint, square with bevel; continue this along the edge and square with joint. Mark on it the distance K L. Then through L draw plumb-line, according to pitch board. Fig. 4 conveys the meaning.

Next, lay on the mould. Keep its edge and the bevelled edge of stuff fair. The mould, in this position, makes tangents on it stand opposite bevel lines on joints. Mark the stuff. This done, apply the mould in like manner to under side. Now take off the slabs, and give the wreath-piece its cylinder form.

[Remember, in working, to hold the plane in same direction as plumb-line through L.]

This done, square over both edges of piece from line through O. Mark half thickness of stuff, giving a point to set off half thickness of rail on each side. Next, take off the top slab. To do this a clear direction is given, the thickness of rail being on both joints and in the centre, making three points through which to work off the slabs. This done, gauge the piece to a thickness. Have the stuff full at centre joint N. This completes lower part of wreath. The mould for upper or level part is seen at

Fig. 5. Let line T V equal T N. Then draw joint through V. Next, set the dividers to half width of rail, and draw small circle at T. Draw parallel with T N, cutting both sides of circle on line T V, which gives points to draw width of mould on straight shank. Set off half width of rail on each side of V. The lines T V and T H being so nearly equal that dividers may be used to draw the mould. Let bevel at T be applied to joint on shank to the right. Use a square for joint V, as shown. Take off slabs in the manner just stated for lower part of wreath. Both pieces are now ready for the screw. Previous to putting together, mark direction of square line on upper and under side of piece at joint V. Then at Fig. 3 mark in like manner at joint N the direction of bevel T. This and square line at joint V must be exactly opposite, when both pieces are together.

It would perhaps be better to use a knife instead of a pencil, in marking bevel lines on centre joint.

Should there be a doubt as to the application of bevel to joint, it may be removed by the following method: Take the mould, Fig. 3, and stand it over plan, Fig. 1. The tangents on mould and those on plan should range. Then the surface of mould represents that of plank, and a plumb-line, or nearly so, being marked on joint, shows the application of the bevel.

It will be also understood that a bevel line passing through the centre of a joint, gives direction for continuing the same on both surfaces of stuff, and square with the joint. The application is to have tangents on the mould stand over bevel line on joints.

The learner will perceive that this application makes joint on mould project over that on stuff. And that on the other side it is the reverse; the curve not reaching joint on stuff. Still, some portion of mould will be found sufficiently near to continue the curve up to the joint.

Fig. 6 shows cut of carriage landing.

This completes the drawing.

PLATE 8.

PLATFORM STAIRS.

FIGURE 1 shows a ground-plan for stairs, in which convenience and simplicity and safety are combined, and which should always be adopted when there is sufficient space. As before stated, the best result depends entirely upon the positions of the risers in the cylinder; if these are placed right, the strings, wreaths, and everything throughout will present a symmetrical appearance attainable in no other way. The first thing required is the height of riser and width of tread accurately spaced off on a rod; the next a ground-plan to work by. The size of cylinder is determined by the length of step and space allowed for stairs; if this should be ample, the larger the cylinder the better. The semi-circle in Fig. 1 shows centre line of rail; its diameter is twelve inches. Two balusters stand on the platform, one opposite half diameter. Set off balusters, making the spaces between their centres equal to half a square step. This at once determines the positions of risers A and B. The same rule applies to cylinders varying from ten to fifteen inches. Proceed now to set off width of step on right and left, giving position of risers landing on and starting from platform. Observe that the face of riser starting should be curved. This may be worked solid, the thickness of riser being sufficient. The elevation of risers and unfolding of tangents as shown from this, we find the length of tangents and height of plank to be used in forming the mould. In this case the height is three risers, counting from A and including B. Draw the elevation of two square steps A and B. Placing them in same position from spring line as on plan (*this is very essential*), indicated by the dotted curves, using A as centre for position of B and S as centre for position of A. Draw upper and lower pitches through corners of square steps, cutting the spring line at H

and P. Divide the distance between the points equally as N; square over from N, cutting upper pitch at C; square down from C, cutting at B. This is the directing point in finding pitch of plank. Draw ordinate A B; from this draw a line at right angles, cutting centre. This is the seat line. Draw from O parallel with ordinate, cutting at R; also draw N, cutting spring line. From A as centre revolve the distance of spring line on one side of square shown by dotted curves, and erect a perpendicular, cutting pitch at L; square from this, cutting at 4. Then 4 N is the height, transfer 4 N to 4 N on plan. Join R 4. This is the pitch of plank. We are now ready to construct the mould Fig. 2. Draw any line and transfer the points R. 2, 3, 4 to Fig. 2, make $RL = RO$, Fig. 1, and 2. O. Fig. 2, equal to radius. This is the minor axis 3 P = to A, and in fact the lines cutting at seat from square coincide with corresponding lines on Fig. 2. Join P and L and N and extend L P. From P apply level D, Fig. 1, cutting pitch line R 4, and extend it. Draw any line parallel with R 4, take any point as C for centre, and with a radius touching P N, cutting at F, square up from C to P W. Join W F. This gives bevel T for joint N. Again take C as centre and a radius touching L P, cutting at E. Join E W. This gives bevel H for shank joint. To find the half of long diameter, square with W. Draw 2 V; make 2 V equal radius. Set off from V each side the half width of rail. Square up as shown, cutting pitch, giving the half of long diameter from 2. To find the width of mould. Draw a line under C and parallel, cutting at J and S, then F J is the half width at N and E, S at K. [The significance of dotted lines to pitch line.] Remarks on preceding page are applicable in this problem.

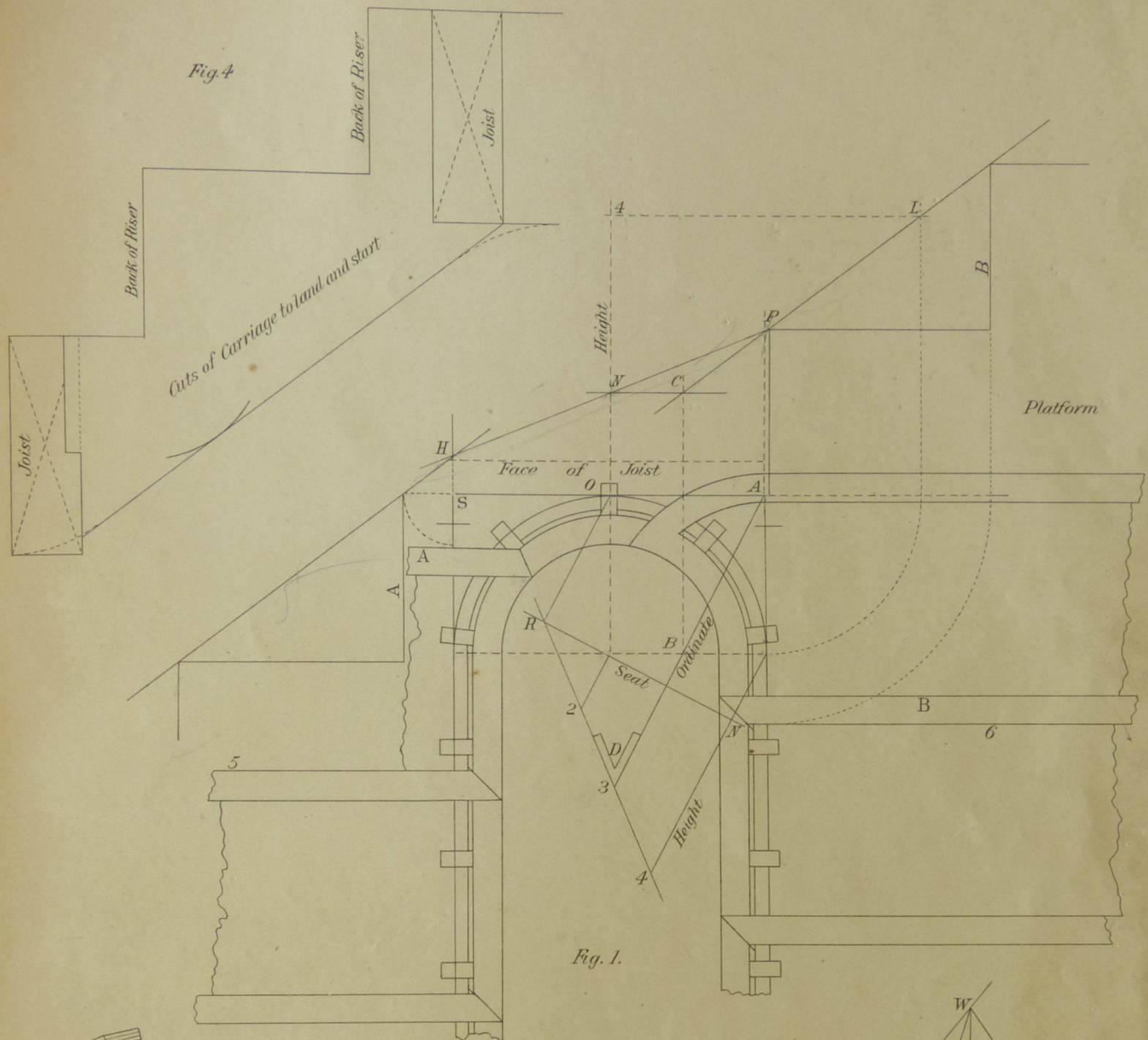


Fig. 1.

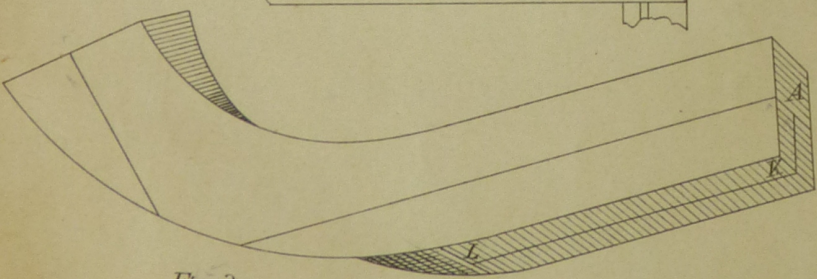


Fig. 3.

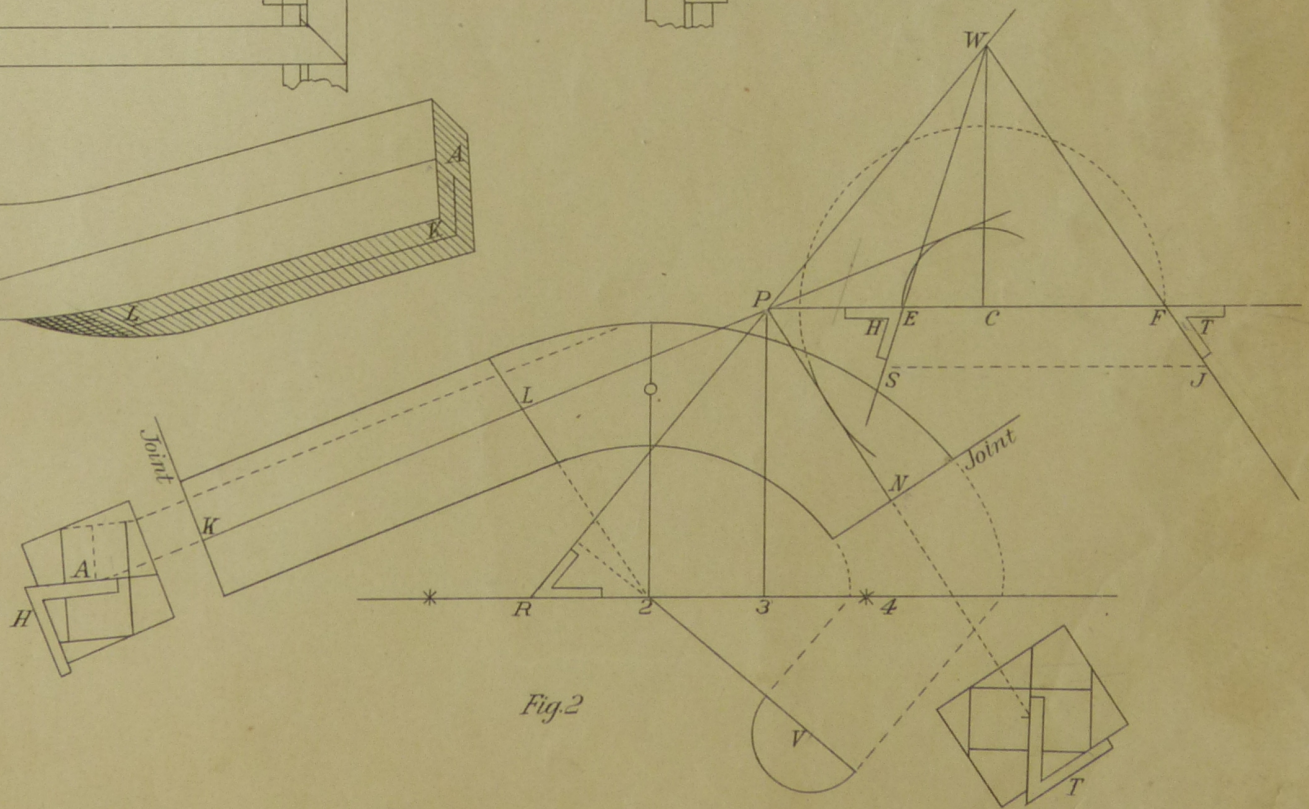


Fig. 2.

PLATE 9.

CONSTRUCTION OF WREATH STARTING FROM A LEVEL FLOOR.—ITS JOINT REMOVED FROM CENTRE OF SEMI-CIRCLE, WHICH MAKES TANGENTS ON THE PLAN FORM ACUTE AND OBTUSE ANGLES.

THE arrangement here presented is entirely different from that given on Plate 7, which shows the wreath for similar situations. It has been found, from practical experience, that difficulty occurs in giving proper easings to a wreath which starts from level to rake. Its upper part being on the pitch standing over square steps, the joint is usually made in centre of semicircle. This causes edge of plank for upper part of wreath to be nearly square, giving more wood than is necessary for thickness of rail, whilst at the centre joint there is scarcely sufficient. Here the difficulty occurs; for, in cutting off the lower slab on straight shank, the cut, if continued, runs into the circular part; or it must stop suddenly at or near the springing line. Then the under slab of circular part being cut off and worked up to straight shank, it is found that the concave side of piece presents a hollow; or, appears like an angle at the junction of straight and circular.

To remove this deformity the centre joint has to be thrown out of square; which may be done by a skilful hand.

The motive for changing position of joint is to obviate all difficulties, and give a better construction, which will show this system of hand-railing adapting itself to all forms of wreath, regardless as to where a joint is situated on the ground-plan. It may be stated that stairs having winders at the starting or landing, there is no difficulty in giving the wreath its proper easings.

We will now commence the explanation of the drawing.

Fig. 1 shows the ground-plan. The cylinder is purposely made large in order to better illustrate the construction. The position of dovetails for balusters gives direction to draw face of second riser, which you perceive stands on a line with diameter of cylinder. Set off the width of a square step, its end being in the cylinder. The nosing and riser have to be curved as shown.

Now fix upon where the joint shall be. For this there is no definite rule. Assume C; through which draw a tangent cutting D and B. This gives A B C D for tangents. That of D E falls level, when in position; whilst D B stands on certain pitches not yet known, until tangents are unfolded or spread out, as

Fig. 2 (on lower part of plate shows). Letters A B C D correspond with those of tangents at Fig. 1. The square step on the right, with two risers, here stand in the same position as first step on plan at the starting. Commence by drawing the pitch on step. Set off half thickness of rail. This draw, cutting through P. Let distance given by long baluster be transferred to the left, and draw under side of level-rail. Set off half its thickness, cutting at L. Join L P. This is the pitch of tangent D B on plan. Next, draw through joint K cutting at Y and S; which gives Y L as height for lower part of wreath.

To find height for upper part, square up from S, and over from N to the left, and we have W S for height.

To find ordinate for upper part of wreath. Take N W in dividers. Set off this distance from joint C on tangent of plan, which gives 2. Draw from it through A, and we have ordinate. Draw again from B and C, parallel with it. Make seat square with it. Let height W S equal that of Fig. 2. Draw from V, through S. This gives pitch of plank; likewise long diameter of elliptic curves.

To draw mould for upper part of wreath. Take a piece of board and lay its jointed edge on pitch. Mark R S T V. Square over from each letter as shown at

Fig. 3. This done, run on a gauge-line any distance from edge of board. Make V K equal V A at Fig. 1. Let T P equal P B, Fig. 1, and S N equal W C at the same figure. Next join K P and draw from P, through N. These lines to be correct, P N K must equal corresponding letters at Fig. 2, below on the right. The next operation is to find bevels for joints. These are obtained by taking bevel 4, seen in angle at Fig. 1. Apply it to edge of board at Fig. 3. Let the line cut through P. Next, draw from P to the right, and square with P T. Assume any point on line just made, say C. Square up from it to cut at D. Take C for centre, and for radius a circle

touching tangents K P cutting at B, join B D, and the angle thus made contains the bevel for joint K. Again, take C for centre, and for radius a circle touching extended tangent N P, cutting A. Join A D, and we have bevel for joint 5 on the left. To find width of mould at both joints. Set off half width of rail above C. Draw to cut both bevels, giving B 2 on the right. Set off this distance on each side of K. Then A 3 on the left, being set off on each side of tangent at joint 5, gives width of mould for straight shank.

To find half long diameter of elliptic curves. Let R O equal O E on plan above to the left. Set off on each side of O half width of rail. Next, draw from R, square with bevel 4. Make R Z equal R O. Set off on each side of Z half width of rail. Draw square with R Z, cutting the pitch.

Now find points to insert pins for sweeping elliptic curves with a string. This completes the mould. Here it will be understood that pitch and long diameter mean the same thing. And further, that the drawing just made is on a board, from which the mould is cut. Should it not be sufficiently wide to show bevels for joints, lay on a piece for that purpose. It would be well to mark the bevels on mould, in order to have them ready when wanted; as it may happen that the piece of board on which the drawing has been made is either lost or thrown aside. So that by using a little precaution we avoid trouble and save time. The next consideration is the mould for lower part of wreath. This is seen at

Fig. 5. To find pitch or long diameter, refer to Fig. 1. There draw a line through joint C, square with O E, cutting at K. Draw from D above, on the left, square with D E, cutting line through C at Y. Make height Y J equal that of L Y Fig. 2 (lower part of plate). Join D J. This gives pitch of plank and long diameter of elliptic curves. Extend line from O to cut at F. Now return to Fig. 5, below. Here the letters D F J show distances which are equal to those above, having corresponding letters. Square up the lines, and make D L equal E D, above. Let J K equal K C, also above. Draw from L through K. This line, to be correct, must equal that having corresponding letters on the right at Fig. 2. Next, find a bevel for joint K, by taking bevel 3, seen in angle above, at Fig. 4. Apply it as shown at Fig. 5, the line cutting through K. Then draw from K to the right, square with K J. Next, assume any point on line just made, say C. Square up from it, cutting A. Take C for centre, and for radius a circle touching extended tangent L K, cutting at B. Draw from A, through B. This gives bevel 6 for joint K, and that of 3 having already been determined by angle above, it applies to joint on shank as shown. Next, let F O equal O E, Fig. 1. Set off half width of rail on each side of O. Here the long and short diameter of elliptic curves are so nearly equal that the dividers may be used for striking the mould.

It will, no doubt, be remembered that bevels for joints always give width of mould; therefore the method need not be repeated here. The application of mould to stuff is precisely the same as that which has been already stated.

The lower part of this wreath, when in position, its shank D falls level. The dotted line shows the slab on top side of stuff as being cut off and worked to bevel 3.

Let plumb lines, which have been made on joint K, of both pieces, stand exactly opposite when the joint is bolted together. This completes the moulds, and shows how perfectly simple the construction is, regardless of where the joint is made on ground-plan. It also shows that where a purpose or object is to be gained the necessity of knowing how to apply correct methods to accomplish that end, as here very fully illustrated in the drawing just presented.

Fig. 6 shows cut of carriage starting. To determine this, make the elevation of a step and two risers. Set off from internal angle of these, say five inches, for lower edge of carriage. Draw the pitch. Then set off from O to P, say ten inches, for depth of joist. Square over from P. This having cut lower edge of carriage, gives L. Square up from L, giving N O as distance, which face of joist stands from the back of riser. Same being shown on ground-plan.

PLATE 10.

SIDE WREATH STARTING FROM NEWEL.

FIGURE 1 shows the ground-plan of stairs. Our first care will be to determine the position of Newel. Let centre O be equal to nine inches from centre of rail on straight stairs.

Fig. 2 shows elevation of one square step and two risers. Draw top of first step, and on this line transfer the distances A B C, Fig. 1. They must bear the same relation as on plan. Draw H O equal to half the thickness of rail, cutting the dotted perpendiculars from B C. Set off the height of Newel from first step marked under side of cap; also half its width, intersecting at O. Square over from H to P. Then P O is the height of tangent C B. Make C D equal C B. Square from B and D, cutting at centre K. Set off each side of centre the half thickness of rail, as shown, and where the cap and rail intersect will be at right angles with ordinate D C. Then K D will be the seat line. It will be seen that the ordinate is level by the elevation at Fig. 2. Care should be taken that the octagon base of Newel is parallel with the ordinate at right angles with seat. Draw dotted line from B; indefinitely from Fig. 2 transpose P O height to H E on Fig. 1. Draw D E extended, at right angle from seat from K, cutting D E at F, gives angle S for pitch of plank. Let us consider for a moment these lines and their positions. If we take a piece of cardboard and cut out the triangle F K D, and another with a base of K B, and a square side equal to K F, and on this place the difference between H E and K F, or in other words draw a line parallel with its base equal in height to H E, draw from F

to E, we have the pitch of K B, we will find a piece that will lay on these two pitch and cover plan K D, C B. As we have said before that D C was level, take F D and H O (Fig. 2), which is the length of tangent B C on pitch, then the adjacent sides will be H O and C D, to stand over D C B on plan and F D and F H, Fig. 3, to stand over plan D K and K B.

We will now proceed and acquire the bevels for joints. These as shown at Fig. 3. Draw any line as F D, and make the distances F E D equal to F E D, Fig. 1. Make D O equal to D C or H P. Draw from E square with F D. Make E H equal to H B, and F R equal to radius. Take bevel S and draw through O, Fig. 3, extended; also draw tangent through points H O extended. Draw any line as O C parallel with F D, and on it take any point as A for centre, and with radius touching tangent, cutting line at C. Square from A, cutting line from S at E; join C B. This gives bevel W for shank joint. Bevel S is the one for joint D. We are now ready to draw the mould. Draw N L *dotted line* parallel with O C, equal to half width of rail. This gives O N to set off on each side of D and C L; on each side of H. F R being the minor axis is equal to width of rail. Locate the foci and sweep the curve. The mitre length is shown at D. The success in producing a pleasing wreath in the most conspicuous portion of a stairs is attained only by care and accurate laying out of mould. The mere reading of this work will not alone suffice, but must be applied.

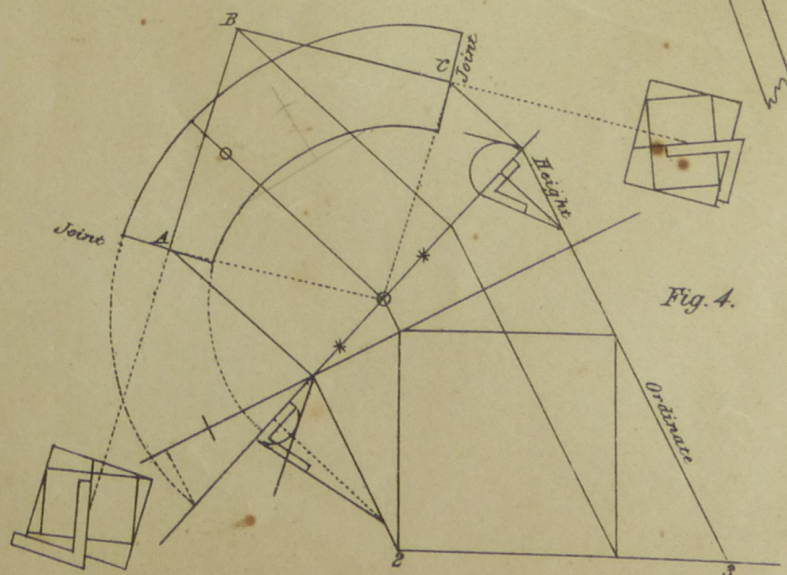
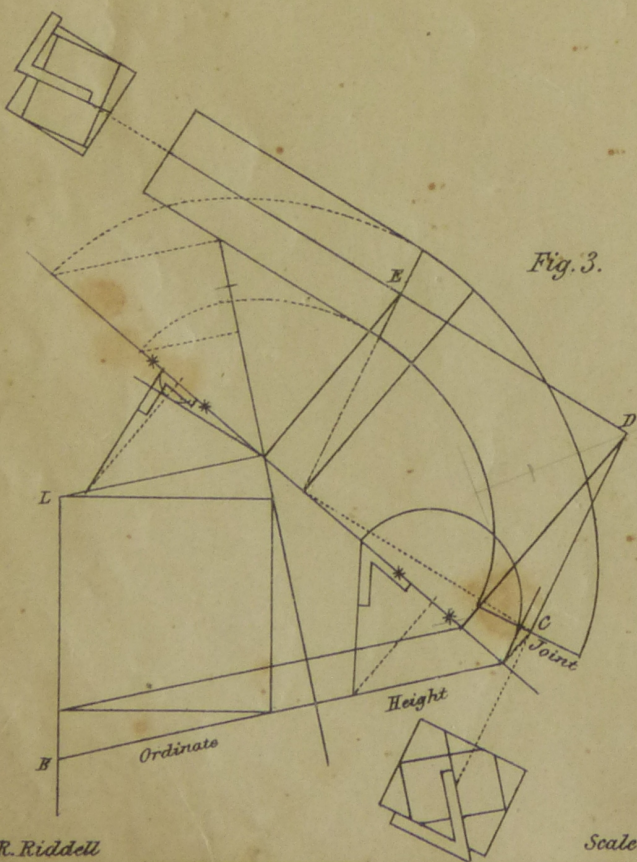
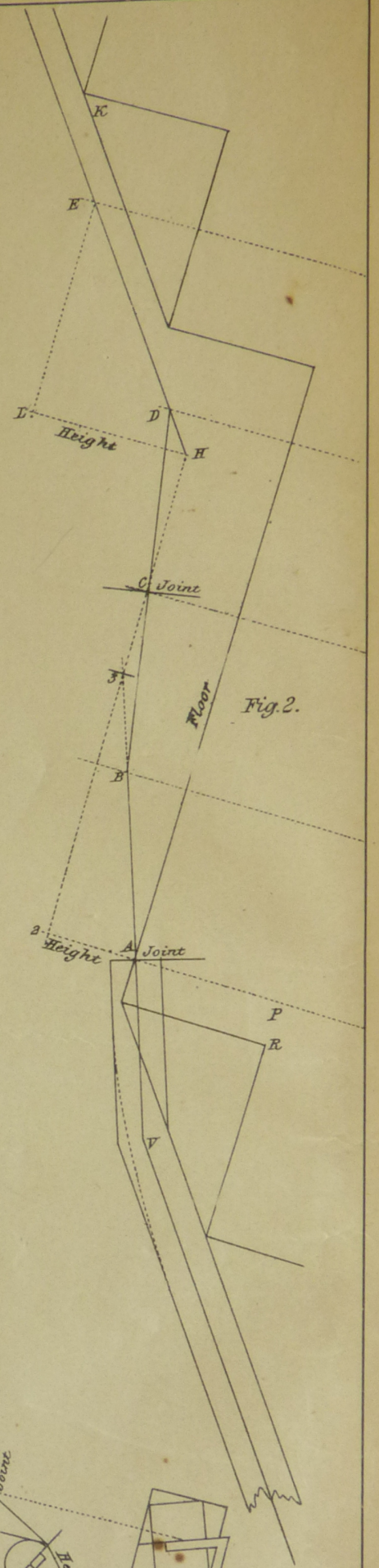
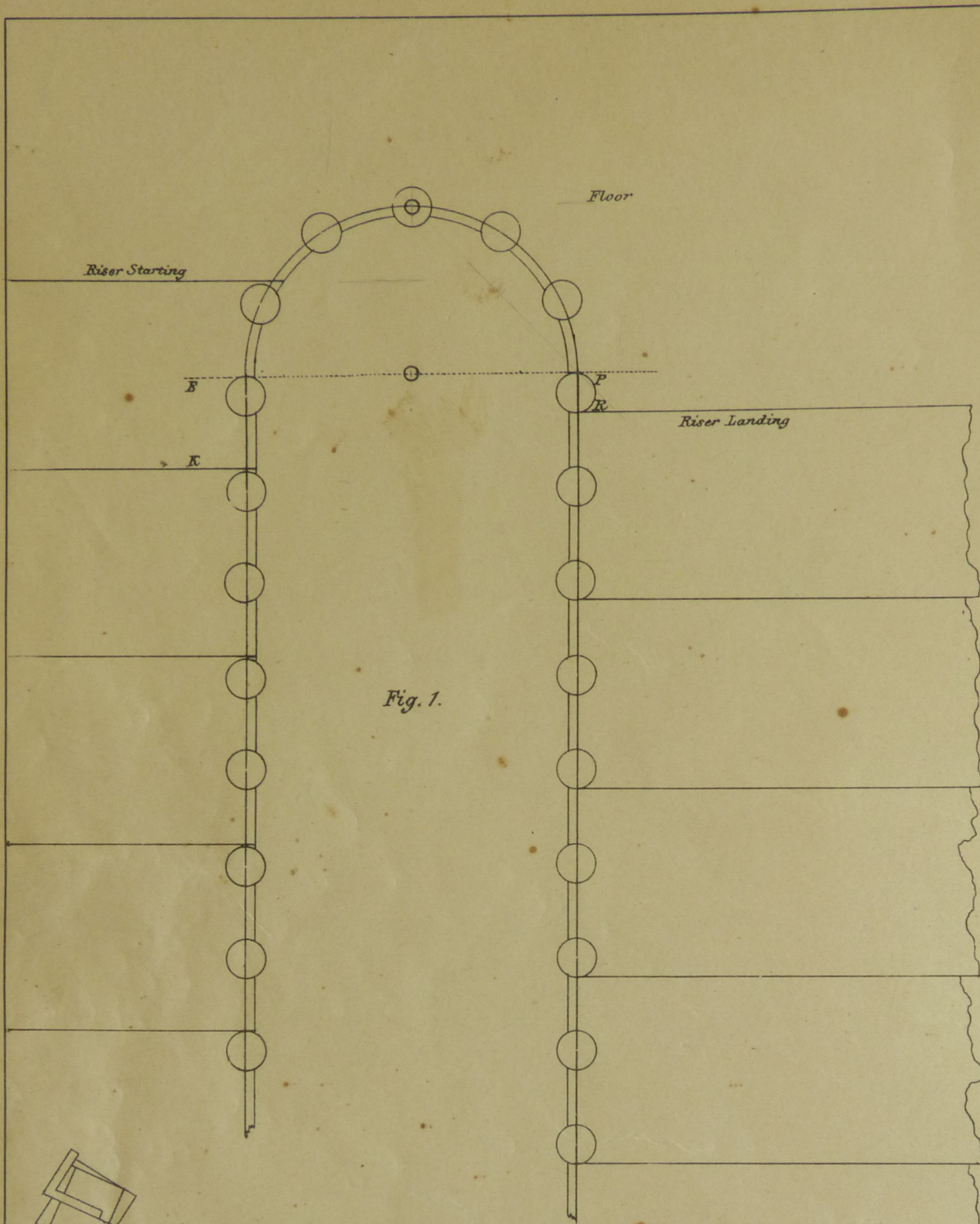


PLATE 11.

CONSTRUCTION OF WREATH AND RAMP LANDING ON A LEVEL FLOOR.

FIGURE 1. It sometimes happens in platform stairs that the last riser landing has to stand on diameter of cylinder, or within a few inches of it. This plan shows R as face of riser landing, and K the second riser starting. The cylinder, sixteen inches diameter; the centre line of rail struck with nine inch radius. These dimensions will not be understood as arbitrary.

The system by which the wreath is produced applies to all plans; no matter what size cylinder, nor how the risers are situated, a wreath can be constructed to suit.

Let margin on the right be the edge of a board. Set the bevel to any angle, say the dotted line at P. This represents diameter on plan. Let P R equal a corresponding distance on plan. Form square step and riser. Next, draw floor-line. This done, set off from A towards E four spaces, each to equal O O on plan. Draw lines; that which has cut at E gives a diameter. Then make E K equal corresponding letters on plan. Next form square step and riser. Let under side of rail rest on steps. Set off half its thickness. Draw parallel cutting through D. The other pitches are discretionary,

say D B and B V. This gives a good ramp, but lowers the rail, as it stands over riser R. That, however, is of little consequence in a situation like this, where the wreath and ramp must form a gentle, graceful curve.

The next consideration is the height and direction for the ordinates. These are obtained by drawing through joint C, cutting at 2 and H. Then square over E L. This gives L H as the height for upper part of wreath, and L E for ordinate; which transfer to the extended side of square, Fig. 3. Draw ordinate, and make seat square with it. Let height equal that just given. Draw pitch and form the mould as usual. The tangents E D and D C, to be correct, must equal corresponding letters on pitches. Square sections show application of bevels.

Fig. 4 shows mould for lower part of wreath. Extend one side of square. Let 2 3 equal 2 3 above. Draw ordinate, and make seat square with it. Let height equal that above. Now, draw pitch. Lay the board on, and construct mould. It is understood that the sides of the squares must always equal the radius which struck centre line of rail.

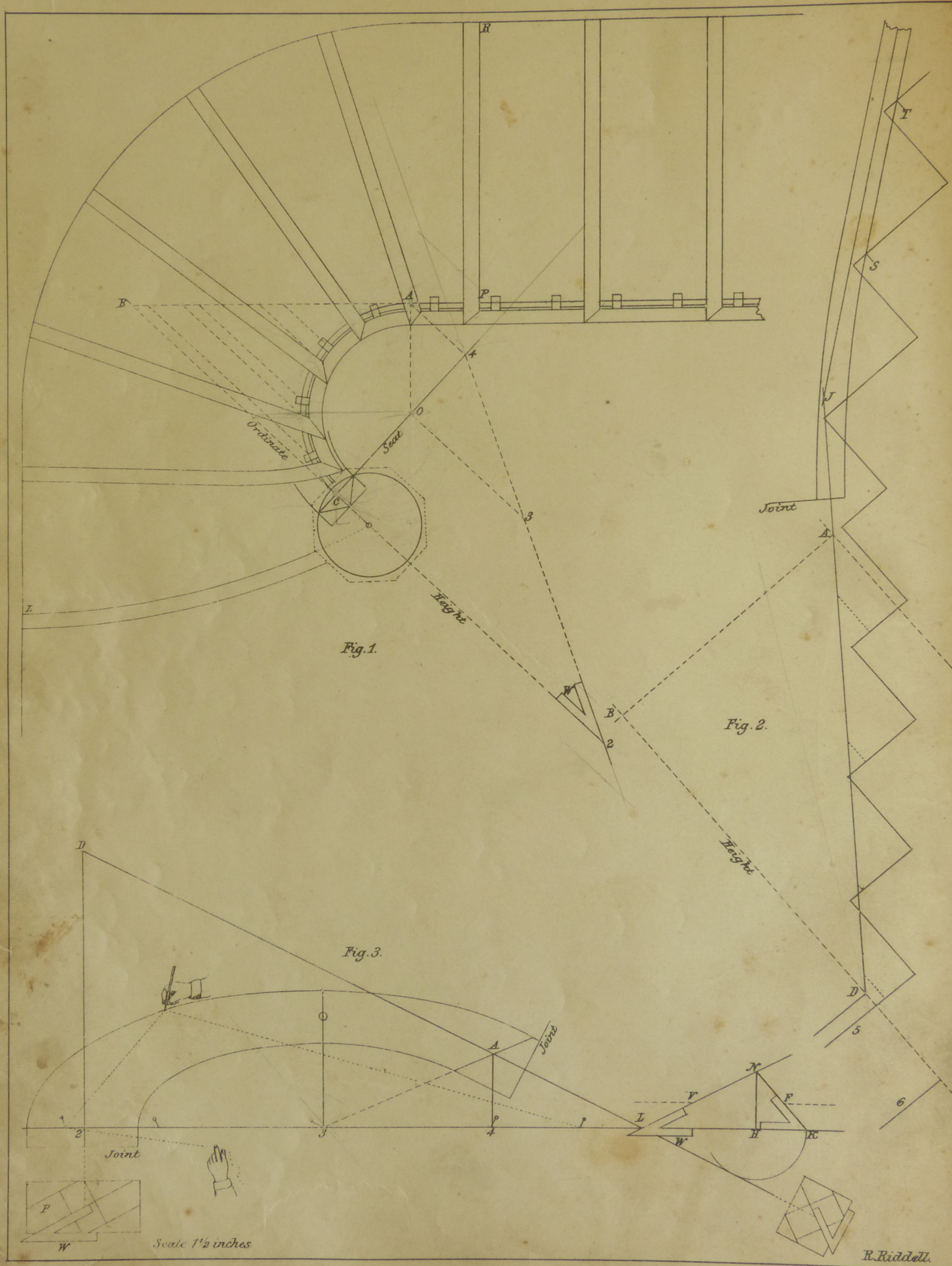


PLATE 13.

CONSTRUCTION OF WREATH, TO STAND OVER SIX WINDERS, AND START FROM A NEWEL.

FIGURE 1 shows the plan. Cylinder eight inches radius. This may be more or less; as narrow end of winders on centre line of rail can always be made to equal half the width of a square step. Let the cylinder be more than a quarter circle. Neglecting this, it will be impossible to produce a wreath with proper easing at the mitre-cap. It is a custom with some to lay down the plan; its cylinder just a quarter circle. Then add one square step to start. Such arrangement is entirely wrong. It fixes the newel in a position to contract the width of stairs at starting; which destroys the whole effect, and makes the work appear to be without design or contrivance. Let this be avoided, and adopt that which produces the best effect. Any portion of a circle, less than its diameter, and greater than a quadrant, may be taken for a ground-plan. To illustrate this—draw a line from centre O, through centre of rail, say at C. Draw through C to the right and left, square with CO. Next, draw from A to the left square with AO. These three lines have determined position of tangents, ordinate, and mitre of cap, and fix the centre of newel at O. Draw first riser at starting. This may be straight or curved. The latter presents a more finished appearance. Have second riser on centre of rail in a position that nosing of step clears the shaft of newel. This understood, take half the width of a square step in dividers, and set off on centre line of rail the number of winders required, which is here six, ending at P. Square over to R. Divide RL on the left into six equal parts. Draw face of risers, and projection of nosings, completing ground-plan. This process is simple and easily understood. The next consideration is the wreath. To construct a mould for this will be equally simple. For example: Draw lines from intersections made by risers and centre of rail, parallel with ordinate, cutting AB. In like manner draw from centre of each baluster in the circle. The lines just drawn have intersected AB, which gives direction to unfold and show the exact position of each winder and baluster in the circle. This is done in a similar manner to laying out a straight string, as is shown on the right at Fig. 2. Here the winders and square steps stand in same position as those on ground-plan. The winders being obtained from intersections on tangent AB. Also centre of balusters. The line 6 seen below, on the right, represents top of first step, and ST above centre of short balusters. Let under side of rail rest on these. Set off half its thickness. This done, fix upon height of newel from top of first step to under side of cap. Assume one riser added to short baluster on square step for it; which fixes under side of mitre-cap at 5. Set off half thickness of rail cutting at D. Draw from it to intersect, say J. Here, it will be observed, the intersection is entirely discretionary. Yet some judgment should be exercised in giving the ramp a gentle curve to meet upper part of wreath. Further, it will be perceived that line AD is the pitch of tangent AB on plan. The plank stands on a different position; as will be presently shown.

Now, find the height of wreath, by drawing from A square with a riser cutting at B, which gives BD for height.

Let C 2, on the left, equal it. Draw from A and O parallel with ordinate. That from A, having cut the seat at 4, fixes a point. Join it and 2, which gives pitch of plank and long diameter of elliptic curves. Here the plank is thrown across the cylinder. Its edge, when in position, is square, standing over seat line. It would be well for the learner, as he proceeds, to understand these points. For instance: The pitch of plank could have been obtained equally well at Fig. 2, by simply setting off from B a distance to equal C 4 on plan. This is of no great consequence, but it shows the importance of having correct ideas of the meaning and intention of lines.

We are now ready for the mould. This can be cut from the board on which it is drawn; and bevels for joints obtained at the same time. For example: Take a piece of board, joint its edge; then run a gauge-line to equal mitre. Next, lay the board on pitch, and mark 2, 3, 4. Square over a line from each, as shown at Fig. 3. Make 2 D equal CB on plan. Let 4 A equal A 4 also on plan. Draw from D through A, cutting gauge-line at L. Then DA, to be correct, must equal pitch of tangent on the right, having corresponding letters.

To find bevels for joints, and width of mould, take bevel W from angle above and apply it here, as shown. Assume any point on gauge-line, say H. Square up, cutting at N. Now take H for centre, and for radius a circle touching extended tangent DA, cutting at K, join KN, and we have a bevel for joint A.

Next, set off half width of rail above H, cutting both bevels; which gives KF to set off on each side of tangent at joint A, and LV to set off on each side of 2, on the left. Thus obtaining wide end of mould by a simple process.

Let 3 O equal OA on plan. Set off on each side of O half width of rail. Find points to insert pins, and sweep the curves.

It is understood that in case the board is not long enough to have tangent DA intersect with gauge-line another piece is to be laid down for the purpose.

The application of mould to plank and bevels to joints is precisely the same as that which has been already given. It is simply to let tangent lines on mould stand opposite to bevel lines on joints. This gives wreath its true cylinder form in all positions. Here the square section on the left shows bevel W applied; its stock on under side of plank; its blade representing point of mitre. This, when in position, stands plumb. Have slab P cut off square with joint. Mark the mitre, same as on plan. This operation and the squaring of wreath have already been stated. Repetition is unnecessary.

There are no two plans alike in this book; and yet, if it contained a thousand different positions of wreaths, of every possible form, there would be no change in the mode of obtaining bevels for joints. Nor would there be any alteration in the drawing of the moulds, or their application to the plank.

It is utterly impossible to make the least mistake, if the system here given be strictly carried out.

PLATE 14.

CONSTRUCTION OF SOLID WREATH FOR QUARTER-CIRCLE STAIRS, THE RISERS AT THE CYLINDER HAVING BEEN PLACED IN A WRONG POSITION TO SUIT PITCHES OF PLANK.

An eminent Western builder offers the following problem for solution:

It is required to produce a solid wreath that shall stand correctly over a given plan* in which one error has been made by placing the risers in a wrong position to suit pitches of plank.

This problem could be solved at once, no matter what the plan may be, or how the risers were situated, if permitted to make the wreath in two pieces, as shown on Plate 20. Such, however, would not be an answer to the question, which proposes a solid wreath without a joint.

We first proceed to notice the plan.

Fig. 1. Here the riser B is made to stand in the cylinder four inches from A; while that of D is fixed on spring line. It is scarcely necessary to say that the whole of this arrangement is wrong. The proper position for risers would be to set off, on each side of C, half the width of a square step. By which means the shanks of wreath are thrown on the same pitch as that made by a square step and riser. This is a fixed and unalterable rule which must be adhered to, no matter how large or small the cylinder may be. As to the pitches of this plan, nothing can be known until the tangents A B C D and two square steps are unfolded.

Fig. 2 shows this. The letters here correspond with those on plan, giving the exact position of risers B and D. Drop a perpendicular from C. Now draw the dotted lines through corners of both square steps. These lines have cut the line from C at R and S, which shows that neither of them will answer for pitch of plank. Because, if P R is taken for the lower pitch this would raise the upper, and make the balusters nearly four inches longer than those below. This, of course, would not be tolerated. The only remedy left is to throw the plank on a different pitch, say the solid line through N V D. Now determine on length of straight shanks, say four or five inches, by which the wreath can be produced with stuff very little thicker than the rail is wide. Here the shanks are made ten inches in order to better illustrate the problem.

Let a joint be made at 3, and square with P R. Extend joint line to the right. This has formed an angle with solid line in which is bevel Y. Now observe that 2 represents half the thickness of stuff, and bevel Y, being applied to top surface of plank, throws the joint out of square until the slab which forms a wedge is cut off. Here is perceived the necessity for having short shanks for the wreath, as 2, 3 shows but half the quantity of stuff that must be added to form a square section of the rail. This will presently be made clear by returning to Fig. 1, and there drawing the ordinate as shown. Draw

again from A and D parallel with it. Make the seat through O square with it. Let L N the height equal that of A N on the left. Draw from E through L. This gives pitch of plank and long diameter of elliptic curves. Now take a piece of board suitable for mould; lay its edge on the pitch and mark K L H E. Square over a line from each letter.

Fig. 3 illustrates this: Run on a gauge-line any distance from edge of board. This done, make L D equal N D, Fig. 1. Let E A on the right equal L D on the left. Make H C equal O C on plan above. Draw from C through A and D. These lines, to be correct, the distance A C and C B must equal N V D. Fig. 2, on the left.

It will be seen that the pitches are equal, so that one bevel answers for both joints. To find it: Take bevel W from angle at Fig. 1, and apply it here as shown, cutting through intersection made by tangent C A and gauge-line on board. Assume any point, say 4. Square up from it cutting 5. Take 4 for centre, and for radius a circle touching extended tangent, cutting at 6. Join 6 and 5. This gives bevel for both joints of wreath.

To find width of mould on straight shanks. Set off half width of rail above 4. Draw the line to cut both bevels. This gives 6, 7 to set off on each side of tangents; and the distance along bevel W being set off on each side of K on the left, gives wide end of elliptic curves. Now make H O equal O A on plan above. Set off on each side of O half width of rail.

Next find points to insert pins. This done, sweep the curves, and the mould is complete.

Let us now notice square section on the right. Here the stock of bevel J is applied to lower surface of plank. Its blade cuts through 2, which is half thickness of plank, or a centre corresponding with that of 2 on the left at bevel Y.

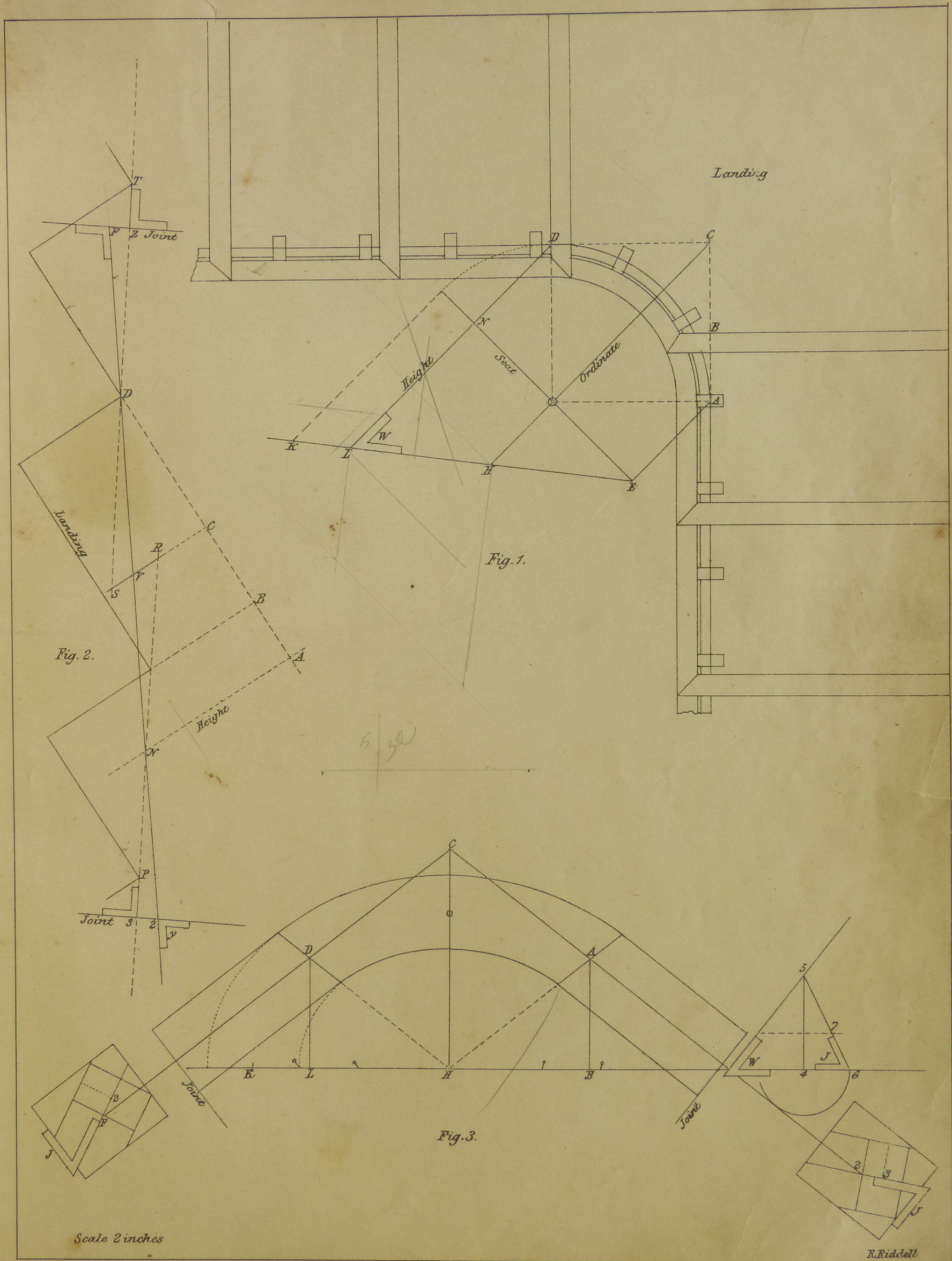
We have then to change the centre by making 2, 3 equal with like figures on the left. This fixes half thickness of rail at 3 on the right. That is to say—when the slab is cut off in the form of a wedge, as shown, the square section on the left shows F as a point standing in half thickness of plank. Make F 2 equal F Z above. This done, shows that 2 on the upper shank will stand on regular pitch Z S. The slabs being cut off in the manner stated, throws both shanks of wreath on their proper pitches, and makes balusters on lower and upper flight of equal length.

This solves the problem. It shows the necessity and importance of having a correct ground-plan.

The matter is fully explained on Plate 19, which shows the proper position of risers for quarter-circle stairs. Also construction of regular wreath for the same.

NOTE.—The following plate is the same as in the First Edition.

* The plan sent us forms the subject of this plate.



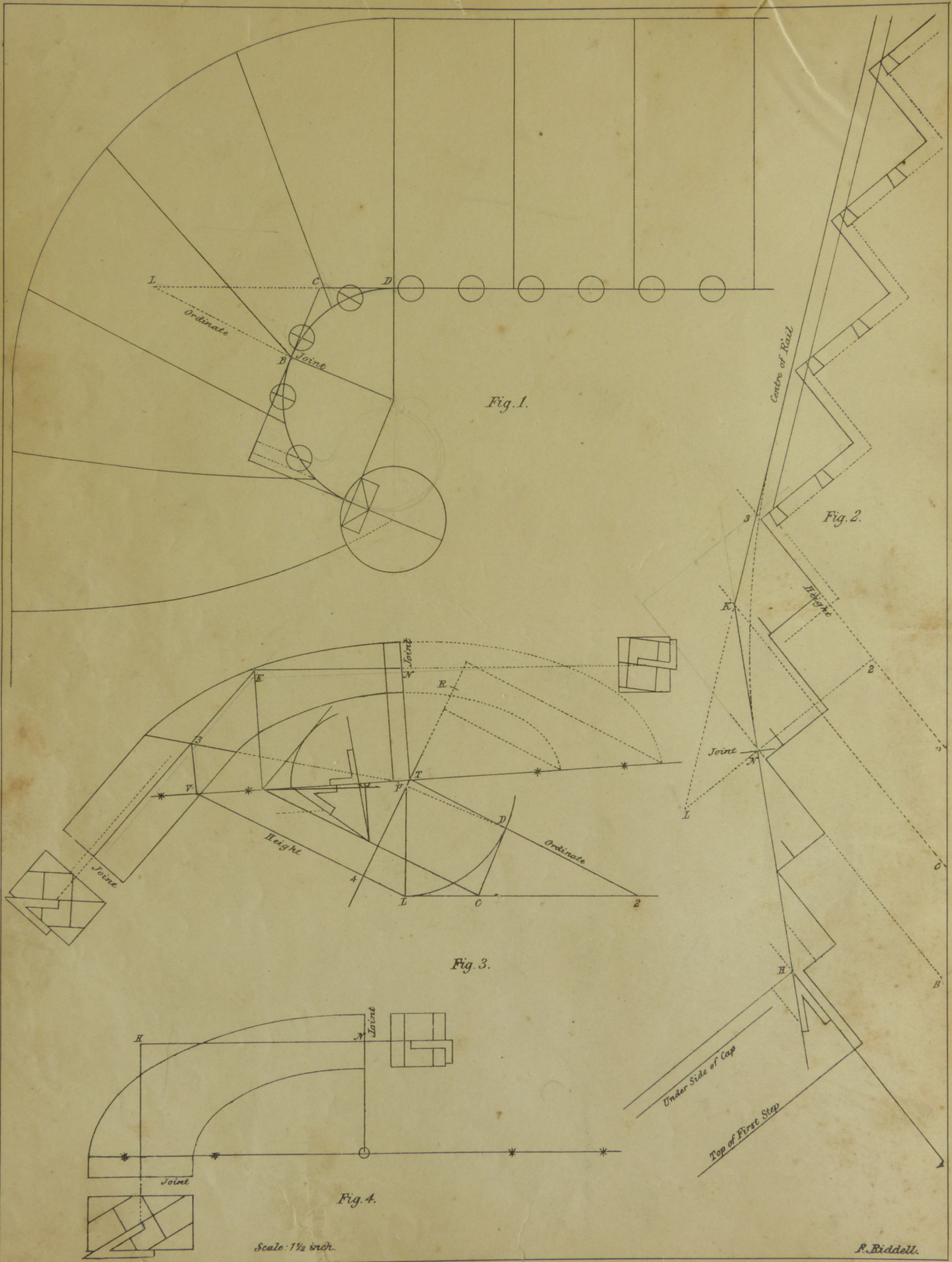


PLATE 15.

CONSTRUCTION OF A WREATH IN TWO PIECES—UPPER PART TO FORM RAMP.

FIGURE 1 exhibits plan of stairs, starting with five winders. The riser of first square step stands on spring. The centre line of rail is struck with a nine inch radius.

It has been distinctly stated, and clearly shown on the two preceding plates, that winders connecting with square steps should not terminate on spring line. The reason is obvious—for, the narrow ends being crowded into the cylinder, naturally causes the wreath to stand on too great a pitch, and thus makes the ramp on upper part short and abrupt. These defects are more apparent on stairs having small cylinders, the wreath seeming to stand almost upright. Such an unsightly appearance can be very easily avoided, by increasing the width of narrow end of winders and letting them run past spring line, in same manner as shown on preceding plate.

Some joiners like to try their hand on this kind of work, without any regard whatever to established rules. The situation of winders and general finish not being taken into consideration, causes the execution of a hand-rail to be not only difficult, but quite destructive of that effect which well-constructed stairs should have.

Take the plate before us as an example. It is seen at a glance that the wreath must of necessity be in two pieces. The question to be decided is: What part of the circle should the joint be made upon, so as to give the least work, and at the same time to produce the best possible effect? This point is speedily settled, by simply drawing the two tangents to form a right angle, the sides of which must equal the radius of the circle. This at once fixes the joint at B, and gives B, C, D as tangents for upper piece of wreath. Then the lower side of square, being extended, gives position of newel and mitre cap. Also ordinate for lower part of wreath; the ordinate for upper part being L B. This however remains unknown until tangents D, C, B and one side of the square are unfolded; which is shown at Fig. 2. Letters along margin on the right correspond with those on plan. Line A represents corner of square; letter B the joint, and C the angle of tangents; while D shows the spring line. Let square steps and winders stand in same position as those on plan.

Let under side of rail rest on centre of short balusters. Set off half its thickness, which draw, cutting at K. Fix upon height of newel above first step. Assume short balusters 2-4, and newel 2-10. Now set off six inches and draw under side of cap.

Next, set off half thickness of rail, cutting at H. Join H K, and we have the pitch of wreath over winders. Its joint N stands over riser B. Height and ordinate for

upper piece of wreath can now be obtained by extending the line marked "Centre of Rail." Then draw through joint N, cutting at L and 2, which gives 2.3, for height, and 2 L as direction for ordinate. Let D L on plan equal it. Join L B. We have now the ordinate for lower and upper part of wreath. Then, by drawing through centre of balusters, parallel with B L, and lower side of square, to cut tangents, gives a direction to show variation in length of balusters standing under the wreath. The method being simply to transfer intersections made on tangents to that of the winders at Fig. 2, where the position of balusters is seen.

Fig. 3 shows mould for upper part of wreath. Commence by drawing any straight line, say L, 2. Let this equal corresponding letters on right. Next, square over L P. Let D, C, L equal similar tangents, on plan. Then draw ordinate through D; also lines from C and L parallel with it. Next, draw seat through P, square with ordinate. Let height 4 V equal that of 2.3 on the right. Join V T extended. This is the pitch. Complete the mould as shown. The straight wood on shank may be any length desired. It forms the ramp, and connects with the straight rail. This piece of wreath having the slabs taken off the sides is ready to thickness. Then cut off the slab from upper side of shank, clear through, and square with joint. This done, notice the corner on the concave side. It gives perfect directions to form the ramp. The square sections show joints and application of bevels. To prove the correctness of mould, see that N K 3, equal corresponding letters, on pitches to the right.

Fig. 4 shows the mould for piece of wreath starting from the newel.

Commence by running a gauge-line on a board to suit mitre given on plan. Square over from any point, say O. Let O N equal one side of square on plan; and have N H to equal corresponding letters on pitch, to the right. Next, find wide end of mould; also, the bevel.

Return for a moment to H on the right; and set off on each side of it half the width of rail. Then draw parallel with H A, cutting pitch. The intersections thus made give width of mould; and the angle formed by pitch and line H A, contains the bevel for joint, on which the mitre is made.

Observe joint N standing on the minor axis, which makes the mould on that line always equal to the width of rail, so that a square is applied to the joint, as shown. Find points to insert pins. Then sweep the elliptic curves with a string.

PLATE 16.

WREATH OVER WINDERS LANDING ON FLOOR.

FIGURE 1 shows the ground-plan of stairs under discussion. Let the centre of rail A equal eighteen inches or nine inches radius, and let the winder equal half a square step on centre of rail. The mould for the wreath is easily found. First find the number of risers over which it will stand. Counting from square step we find six. Then make the elevation of square step and riser, Fig. 2; here unfold twice the radius as shown. Set off seven risers from top of square step and draw floor line. (The measurements of steps are taken where tangent cuts risers.) Above this mark a half riser. Set off half thickness of rail, cutting perpendicular D at 5. We are now ready to draw lower pitch of wreath to connect with ramp over square step.

Set off from square step one half thickness of rail. Draw 5, 3 square over from 4 C to H. Join H 3, intersecting at 6. Draw A perpendicular to 4 C. Then H A equals H A, Fig. 1. The ramp or easing is shown at 6. We will now find the bevels and sweep the mould. Make B H, Fig. 2, equal B H, Fig. 1. Draw ordinate H C, and draw parallel from it a line from B; also 3 and A. Square from ordinate, cutting centre 3 the seat line. Draw C J, Fig.

1. Make 2 N equal A 2, Fig. 2, the height. Draw J, N, R. This is the pitch of plank. Draw any line as Fig. 3, and transpose the distances J, K, L, N, and make R K equal to one half the long diameter, and make J 4 equal to J C on plan; K O equal to 3 C; L 3 equal B; N 2 equal to 2 A, or in other words, the points following will stand over each other. 2, Fig. 3, over A, Fig. 1; 3, Fig. 3, over B, Fig. 1; K over 3, J over J, and 4 over C. Join tangents points 2 3 and 3 4. To be accurate, they should equal 2 and 3 and 3 and 4, Fig. 2. The bevels for joints are shown, and their construction is very clear. The perpendicular A B is optional in length. *See bevel for joint.* The mould for upper wreath forms its own ramp. Make 4, 5 equal to 4, 5, Fig. 2, and 5, E equal to D E, Fig. 1. This tangent is level. As will be seen, that joint 4 is the minor axis and tangent parallel with it must be level therefore. The bevel for joint 4 is a right angle. Bevel V is shown at Fig. 2, and directs the width of mould at E. The dotted line at Fig. 3 is the half width of rail, and gives the width of rail at joints. Note the dotted line on plan, cutting tangent B C is shown on Fig. 2 near 3.

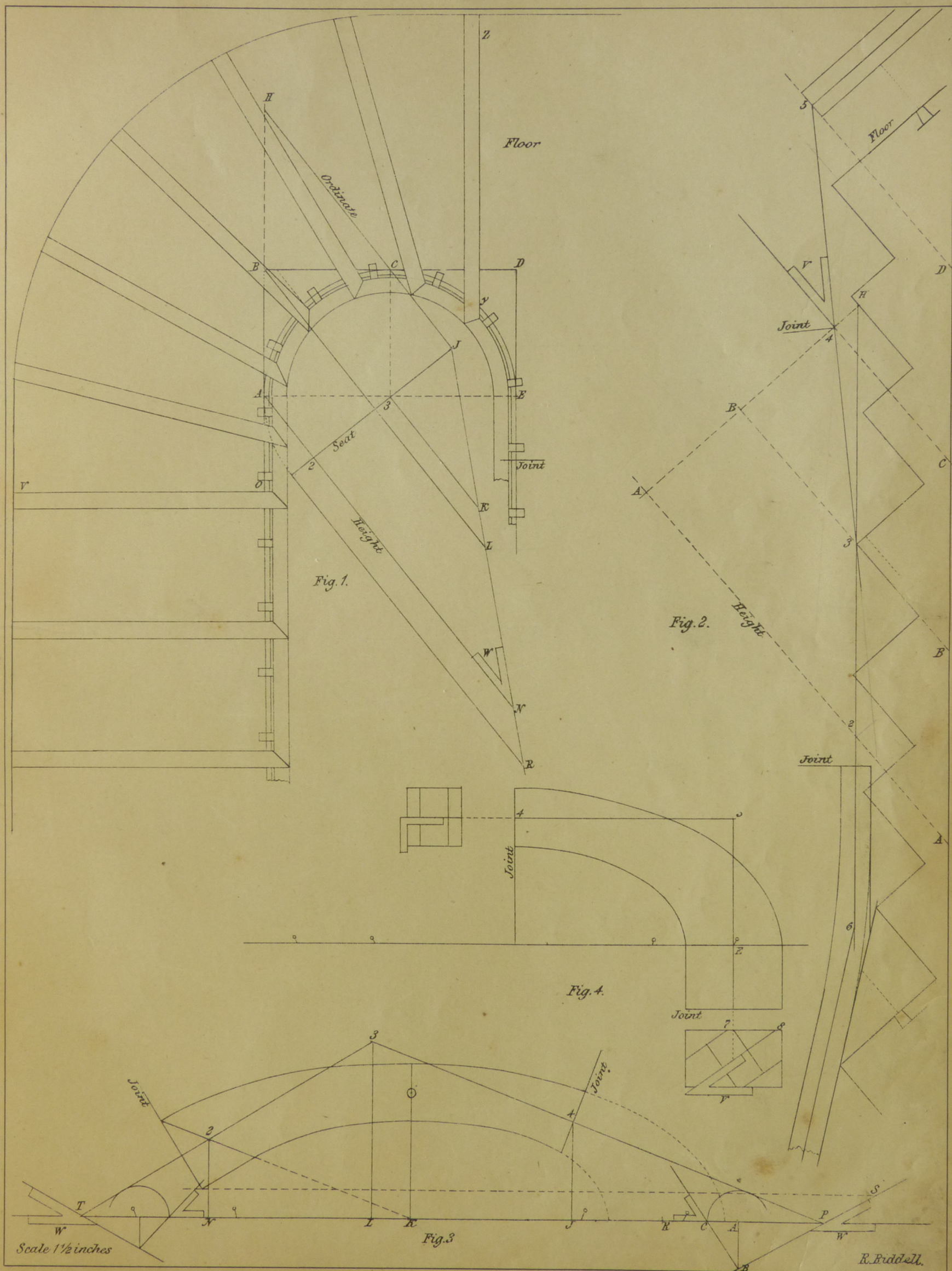


Plate 17.

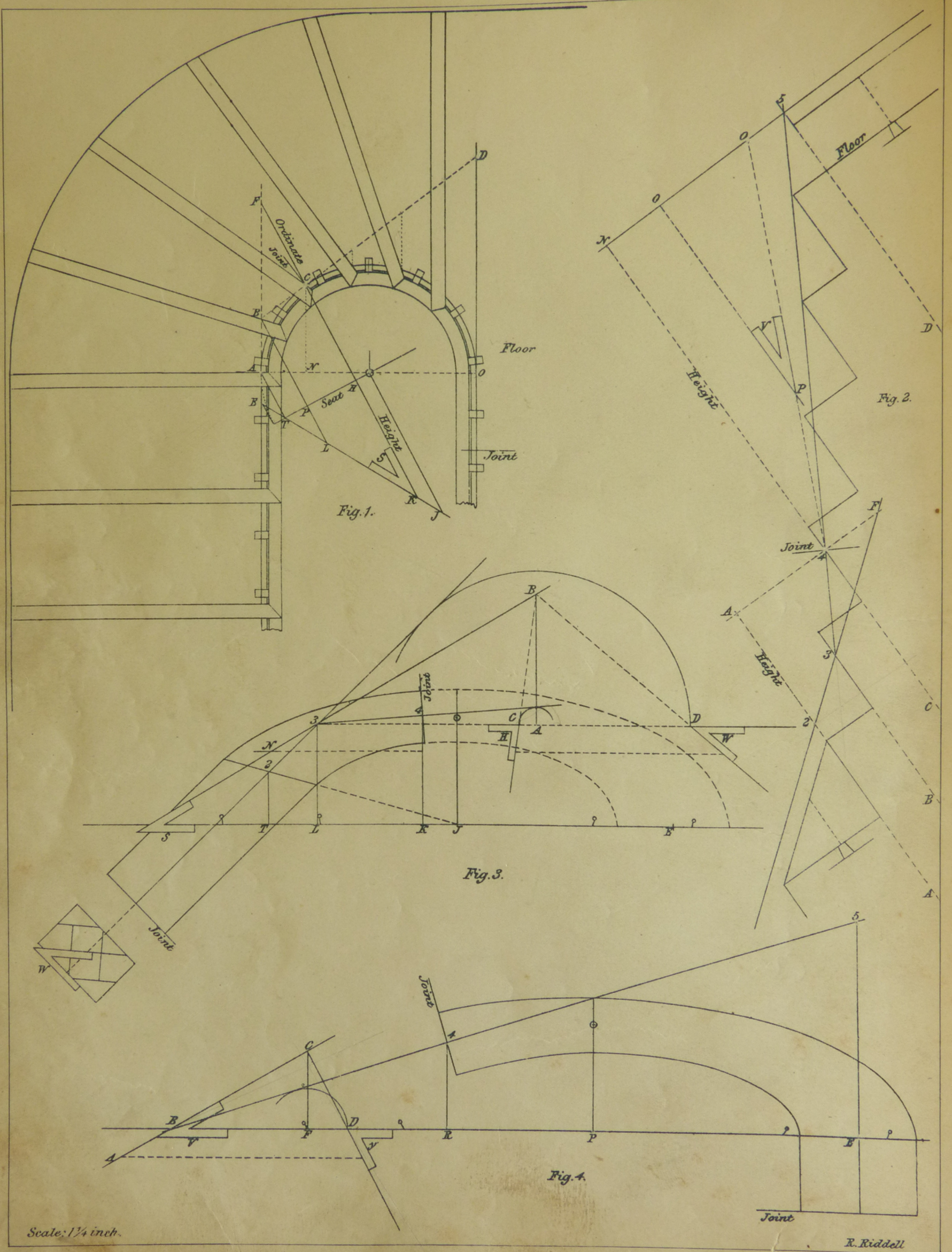


PLATE 17.

WREATH OVER WINDERS LANDING ON LEVEL FLOOR CONTINUED.

FIGURE 1 shows the ground-plan of stairs under discussion. This is essentially different from the preceding problem, the riser A starting at the spring line. Let each winder be equal to half a square step on centre of rail. In this case we will place the joint out of the centre, thus making acute and obtuse angles on tangents. We will assume the joint at C extend A B. Draw B C, cutting at D. This is the plan of tangents. Now unfold the tangents at Fig. 2, and on the left draw a square step and riser. Lay out the winders as at Fig. 2. Care should be taken that the proper distances are acquired. The dotted lines, where they cut the tangents, are the face of risers, and the steps should be made equal to them. This done, set up half a riser from floor line. Mark half the thickness of rail, cutting perpendicular at D 5.

We will now find the pitch of lower wreath. Draw a line half thickness of rail over lower step, and from 5 draw to 3, intersecting lower pitch. Also cutting joint at 4 at right angles with perpendicular C. Draw a line right and left. Extend perpendicular A till it cuts the line from 4 at A. Then A 2 is the pitch of lower wreath. To find the ordinate, Fig. 2, let A 4 extend till it cuts the lower pitch at F, and make A F, Fig. 1, equal to it. It will be observed that the points C F, Fig. 1, are level; also A F, Fig. 2, and F is the distance the lower pitch runs into the plan. Draw from F through joint C, extended and at right angles to it from centre O. Draw seat; also perpendiculars from B A, cutting at T and P. Make H K equal to A 2, Fig. 2. Join T R; also perpendicular from O, cutting T R at J. Take A O radius and revolve it on seat line and from the extremity.

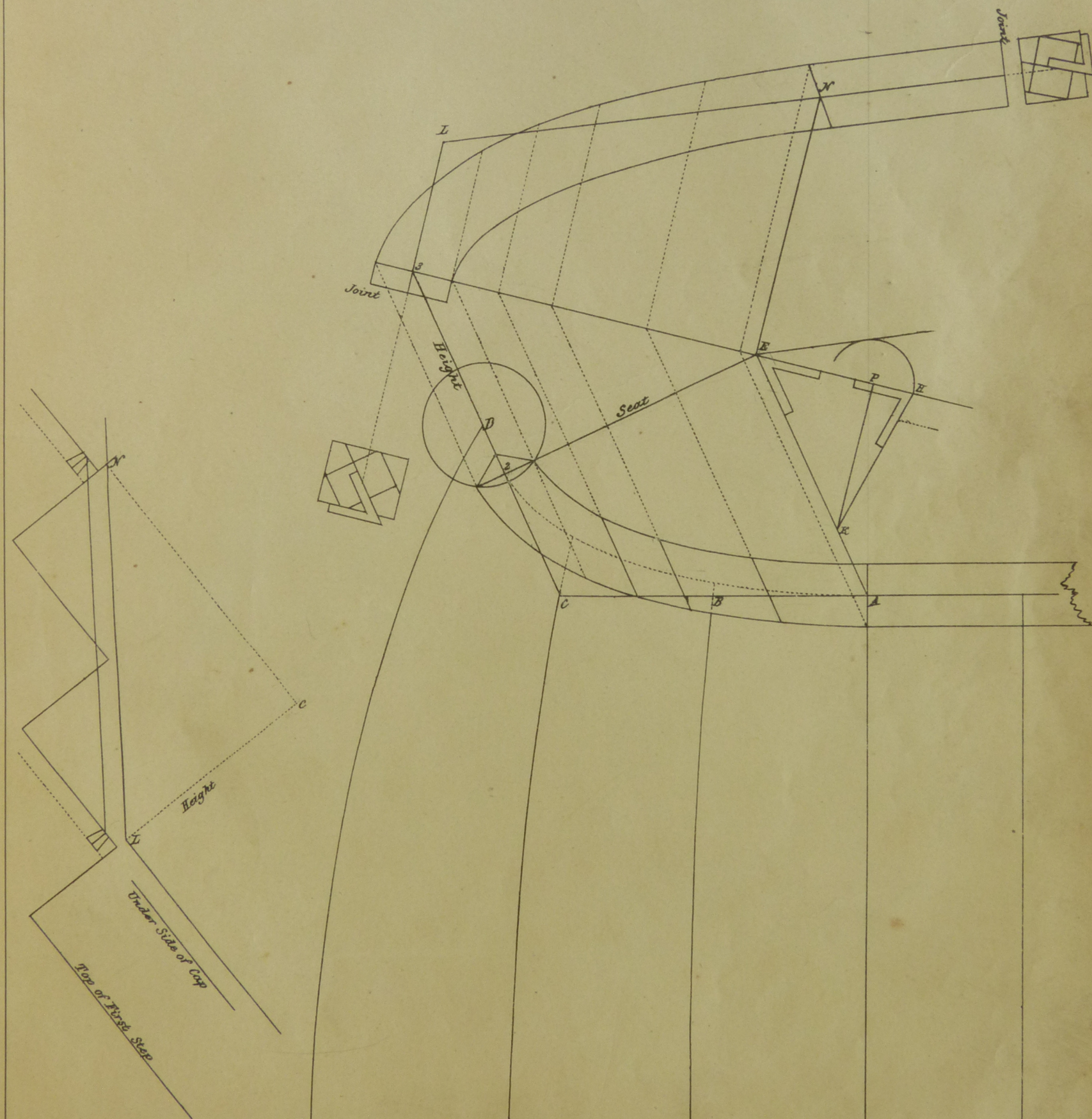
Draw a perpendicular, cutting J T 2 at E. This is half of long diameter. We will now draw mould. Draw any line as in Fig. 3, and transpose the distances along J E. Set off K from J also L T; erect perpendiculars at these points, and make J O equal radius on plan; K 4 equal to H C, and 3 L equal to P B; 2 T equal to A T. Join 3 2, 3 4 extended. Then 3 4 will equal 3 4, Fig. 2, and 2 3 equal 2 3, Fig. 2. We have now the angle of tangents. Our next care is to acquire the bevels; turn to Fig. 2. Make N O equal N O, Fig. 1 (*note the perpendicular form C*). Join 4 O, Fig. 2; this gives bevel V for upper pitch. Apply bevel at S, Fig. 1, to Fig. 3, from 3 extended. Draw from 3, the dotted line parallel with T E, and any centre as A, and radius touching the tangent 2 3, cut at D. Draw B D. Bevel W is for the shank joint; again from centre A radius touching tangent 3 4, cutting at C. Draw B C, gives bevel H for joint at 4 or C. To find the width of mould, draw lines parallel with 3 D, and equal to half width of rail; gives 3 N to set off each side of 2; also at W and H for their respective joints. Now draw mould for upper part of wreath. As tangent O D is level, make E 5, Fig. 4, equal to it, and E P equal to O P (*note that N O is the base and 4 N is the pitch, and O O is the radius, hence the lines O O P, Fig. 2*); E R equal to O 4. Transpose C N, Fig. 1, to R 4, Fig. 4, P O equals radius. Draw from 5 through 4 extended, then the points 5, 4, R, P, E, Fig. 4, must stand over when in position, their points on plan, viz., D, C, N, O, O. The bevels for joints are shown at the left, and need no comment; their construction is evident.

PLATE 18.

SIDE WREATH STARTING FROM A NEWEL.

THE ground-plan of stairs is shown with a curved side, and curved or swelled steps. The face of riser on first step starting or springing from the centre of Newel, as in plate 10, but with three steps curved, presenting a rich appearance. First draw the ground-plan, then set-off the height of as many risers as the proposed wreath will stand over; in this case three from top of first step. Draw from short balusters the rail, and set off half its thickness, and draw parallel with it; then draw the under side of cap the proper height, and set off half its thickness, intersecting at L on face of riser. Draw from N parallel with steps, and from L parallel with risers, cutting at C. This gives LC for height of tangent CA. By this construction the tangent DC is level. The position of Newel is optional, only governed by circumstances of space and taste. Make C 2 on plan equal CB, and at right angles with it draw seat line. This line will

be the intersection of cap and rail. Draw, square with seat the height 2 3 equal to CL. Draw from A square with seat cutting at E. Join 3 E extended. We are now ready to sweep the mould. Draw the curves of rail on plan. Square over EA; also the dotted lines to pitch 3 E. Square the lines from 3 E, and make their distances equal those on plan. The construction of joint N is shown. Make 3 L equal 2 C. Join LN. These are the tangents on mould, and the curve traced through their points as shown will form the curve of mould. To find the width of mould at cap square over to pitch the width of rail to obtain the bevels. Draw from E parallel with LN, and from any centre as P drop a perpendicular cutting EA at K, and with a radius touching tangent, cutting at H. Join KH, this gives bevel for joint N. The pitch at E gives bevel at cap. The half width of rail is shown at H for joint N.



Scale: 1 1/2 inch.

E. Riddell

Plate 19.

PLATE 19.

SOLID WREATH FOR A QUARTER CIRCLE STAIR.

FIGURE 1 shows the ground-plan. Two sides of the square are tangents to a quarter circle, which is the centre line of rail. Let us now place the risers on plan in such a position as will throw straight wood of wreath on the same pitch as stairs. To do this set off from B half a square step on each side of the square. Draw riser landing, and starting, riser starting is shown at 2. The framing of stairs is shown, the starting carriage and landing carriage. The position of risers laid down unfold tangents A B, B C. As shown there, D 3 and 3 A are the length of tangents, for it is evident that they are on the same pitch as stairs. Any alteration in the position of risers given would be a wrong construction, and would leave the wreath to be in two pieces, or to be laid out as shown in Plate 14, which shows a wrong construction of stairs, and to avoid any difficulties it is better to lay the plan correctly. We will now proceed to sweep the mould, from the two sides of square, as A B, B C; extend A C, which is the ordinate. Draw at right angles with ordinate from A a line, and from B parallel with ordinate, cutting line at L. From L draw parallel with A B a line; extend the ordinate, cutting at T; extend L A. This is the seat. Set off on this D equal

to A B from A, from D as centre. Square up the width of rail, cutting line L T; this gives the half of long diameter. Make T S equal to T L. Square up from these points, and make T R equal to A C and L E, and S K equal to L B. Join B K and E; make T V equal to A B. Then R E, R K will equal A 3, B C *on pitch*. The simple yet accurate construction is shown by applying the tangents on their pitches, and they will stand over their respective points. The joints have the same bevel as tangents are equal. Make B 3 equal to L B; join C 3, then B as centre radius, touching C 3; cut B 3 as shown, gives the bevel for both joints. The dotted line equal to half width of rail gives the distance each side of E and K. Note the application of bevels.

In regard to the application of moulds for giving wreath pieces their cylinder form, there is only one correct way, and that is keep tangents on mould surface opposite tangents on surface of plank. Here understand that it is the bevel for joints which directs the tangents on surface of plank. The width of mould is shown to be equal. By taking half its width, and setting off from A, cutting through 3 and the level line at D, gives 2 P equal to K 2.

PLATE 20.

QUARTER-CIRCLE STAIRS—WREATH IN TWO PIECES

FIGURE 1 shows ground plan. Centre line of rail struck with a radius equal to one step and a half.

This arrangement gives three balusters on landing. The rail may be four or six inches wide. The concave side of wreath will present a curved line, having neither cripple nor deformity. The grain of the wood runs nearly in the same direction as that of straight shanks.

Let the quarter circle be divided into two equal parts. This makes the joint at C; so that one mould answers for both pieces of wreath. Draw tangent through joint, and square with C O. This gives four tangents of equal length, as shown by A, B, C, D, E. These are unfolded at Fig. 2.

Have the two square steps and landing stand in same position as those on plan. This done, draw pitches cutting at T and L. Join T L [and not the corner, as shown by mistake of engraver].

Then the pitches H L K, on lower part of wreath, are equal to those above—showing that one mould answers both pieces.

Find height, by drawing from joint K, which gives A H. Next find a direction for ordinate by extending H L, cutting at 2, which gives A 2.

Fig. 3 shows construction of mould.

Let O A E be a right angle. Make its sides equal O A, Fig 1. Join O E. Let O C equal O A. Make A B equal one of the tangents on plan. Join B C.

Let A 2 equal corresponding letters on the right. Join 2 C extended. Let seat be drawn through O, cutting at P, and square with ordinate.

Next, draw from A and B parallel with ordinate. Make P R, the height, equal that of A H on right. Join R V. This is the pitch.

The elliptic curves are more readily obtained by drawing the pitch through O, and parallel with P V. Then extend seat, and let O S equal O A. This done, set off on each side of S half width of rail.

Now draw square with seat cutting pitch, and we have the wide end of elliptic.

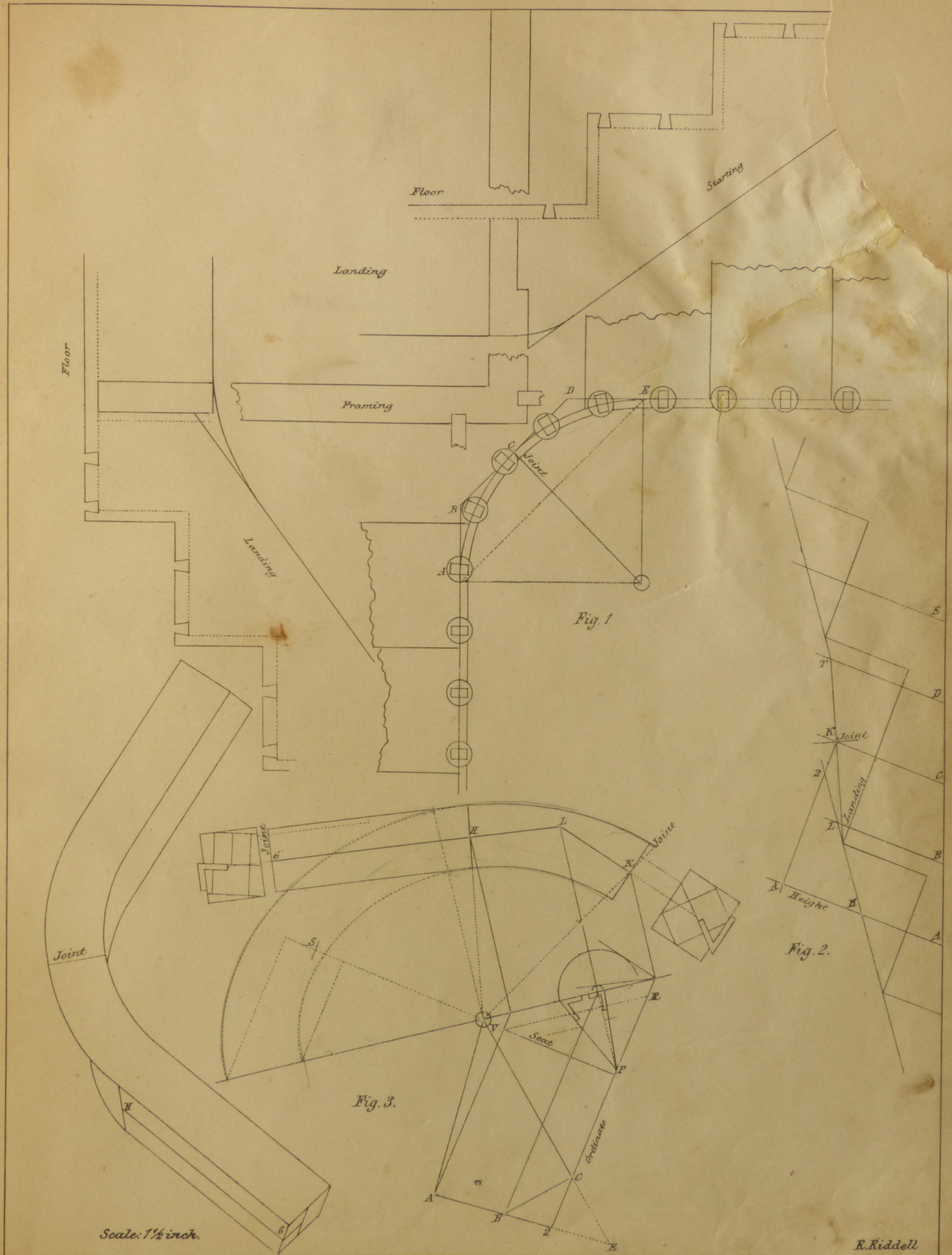
The drawing is now ready to lay a board on for the mould. See that the tangents K, L, H agree with pitches on right having corresponding letters. Square sections show the joints and application of bevels. Cut the slab off the shank, and work it to bevel. Draw a line through half thickness of rail as shown. Continue this along beveled edge, and square with joint. Transfer H 6 to it. Mark pitch, similar to that shown on left.

Be careful to make no mistake in application of bevels. The mould, as it now lies, represents upper surface of lower piece of wreath. This answers for piece above, by reversing.

The strings for these stairs may be plank.

The cylinder staved.

The joints should be screwed from the back.



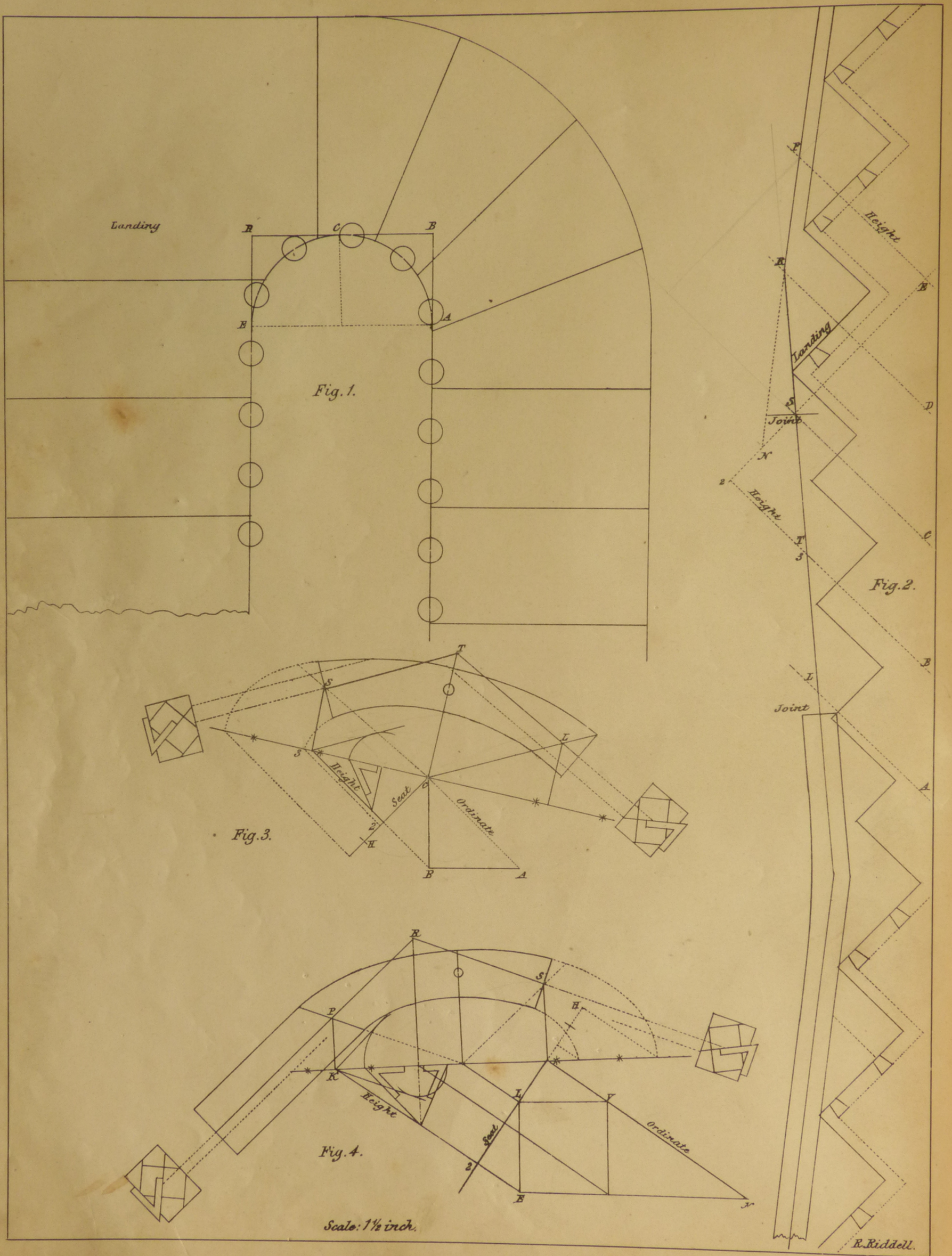


PLATE 21.

CONSTRUCTION OF WREATH FOR STAIRS HAVING FOUR WINDERS, QUARTER LANDING, AND SQUARE STEPS.

FIGURE 1 exhibits the ground plan. The centre line of rail enclosed by tangents A, B, C, D, E. These are unfolded at

Fig. 2. The letters along margin correspond with those on plan. Let under side of rail rest on corners of square steps. Set off half its thickness. Draw upper part to cut R. This is a fixed point, and stands over D on plan. Draw pitch over winders, say through L. This shows that the upper part of wreath forms its own ramp. Two moulds will be required. Find heights by drawing through joint S, cutting at E and 2, which gives E P as height for upper part, and 2 3 for half the height of lower part.

Mould for this is given at Fig. 3. Let A B C equal corresponding letters on plan. Join A C ordinate. Draw from B parallel with it. Make seat square with it. Let 2 3, the height, equal that on right having corresponding figures. Join 3 C extended. This is pitch and major axis.

Next find points of elliptic curves on pitch by making C H equal C B. This done, set off on each side of H half width of rail. Then square up to cut the pitch.

The drawing is now ready for the mould. The tangents L T and T S being equal, one bevel answers both joints. See that L T S agree with pitches on the right, where similar letters are shown.

Fig. 4 is the mould for upper part of wreath. Let square equal one of those on plan. Extend side E N. Let this equal E N, Fig. 2. Join N V ordinate. Draw from other three corners of square parallels with ordinate. Make the seat square with it. Let the height 2 K equal that of E P on right. Draw pitch from K, through intersection of seat and ordinate. Find elliptic curves on pitch by making L H equal L V. The dotted lines that are parallel with ordinate give the points. The drawing is now ready to lay a board on for mould, it being struck with a string.

Tangents P, R, S must agree with the pitches on Fig. 2 having similar letters.

Square sections show joints and application of bevels.

It will be observed that the square steps and winders at Fig. 2 stand in the same positions as those on tangent lines of plan.

PLATE 22.

CONSTRUCTION OF WREATH FOR STAIRS HAVING WINDERS, QUARTER LANDING, AND SQUARE STEPS.

THE upper part of wreath forms its own ramp.

Fig. 1. This plan exhibits joint thrown from centre, making tangents A, B, C, D, E which form acute and obtuse angles. Centre line of rail struck with radius of nine inches.

Fig. 2 shows tangents, winders, and square steps, spread out. Letters along margin correspond with those on plan.

Commence, as usual, by letting under side of rail rest on square steps.

Set off half its thickness, cutting through 5 on upper part. Then 5 is a fixed point and stands over D, on plan.

We now want pitch over the winders, which must be drawn in such a manner as to make a proper ramp. Assume 5.2. This makes lower part of wreath have equal pitches. When such is the case, one-half the height is sufficient for construction of mould. For example: Square over 2 B. Then B 3 gives it.

Height for upper piece of wreath is obtained by drawing through joint 4, cutting at E, giving E 6. The direction of ordinate being E N.

Transfer this to Fig. 3, where corresponding letters are shown. Square over E H. Let this equal E H on plan. Make tangents E, D, C agree with those of Fig. 1.

Draw ordinate through C. Make the seat square with it. Draw lines from D and E parallel with ordinate. Make P V, the height, equal that of E 6, on the right. Join V K extended. This is the pitch, and the major axis.

Find the length of elliptic curves; also points to insert pins for striking mould.

See that 4, 5, 6 agree with corresponding figures on pitches to the right. The straight shank of wreath may be any length desired. The dotted line from corner of rail and on surface plank, shows the slab that must be cut off, according to bevel.

Fig. 4 is the mould for lower piece of wreath. It has been stated that when pitches are equal, and tangents on ground plan make a right angle, then the ordinate is always the diagonal of a square.

Here the tangents on plan show the acute angle, meeting at B. Then the sides give the right angles A H and C H. Join H B, and we have the ordinate.

This makes the construction very simple.

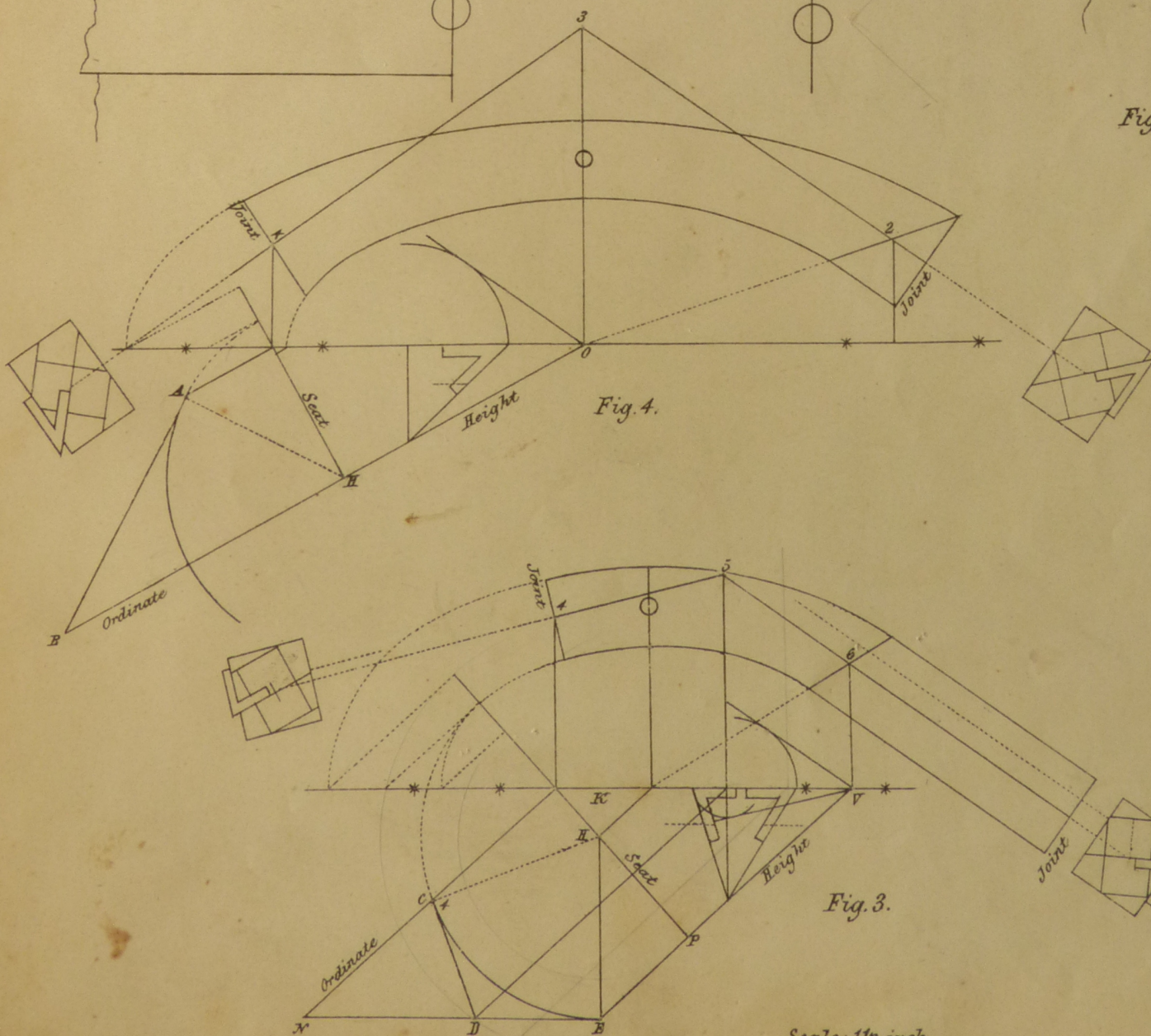
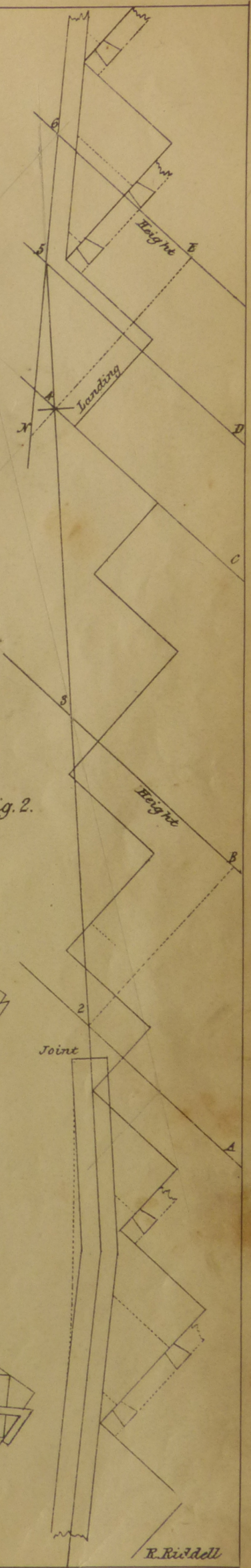
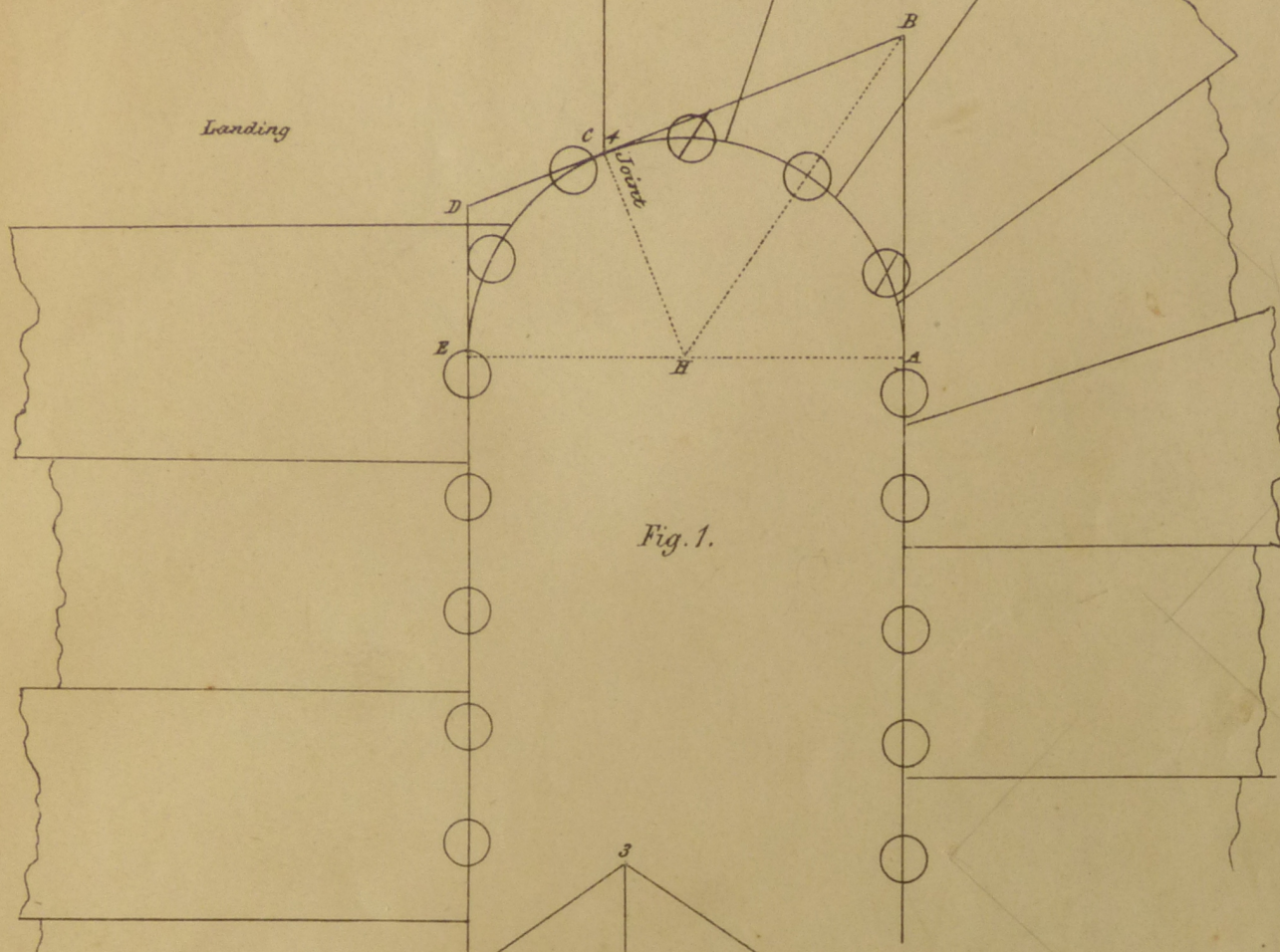
Commence at Fig. 4, by drawing a line in any direction; say, that marked "Ordinate and height." Let B H agree with similar letters on plan. Square over the seat from H. Draw curve to equal that on plan. Have B A agree with A B on plan. Draw from A to cut seat, and parallel with ordinate. Let H O, height, equal that of B 3 on right. Draw from intersection of seat through O, and we have pitch and major axis.

Find length of elliptic curves, as usual.

The drawing is now ready to strike the mould.

Its tangents are 2, 3, 4, and must equal corresponding figures on the right.

The pitches here being equal, one bevel answers for both joints.



Scale: 1 1/2 inch.

R. Riddell

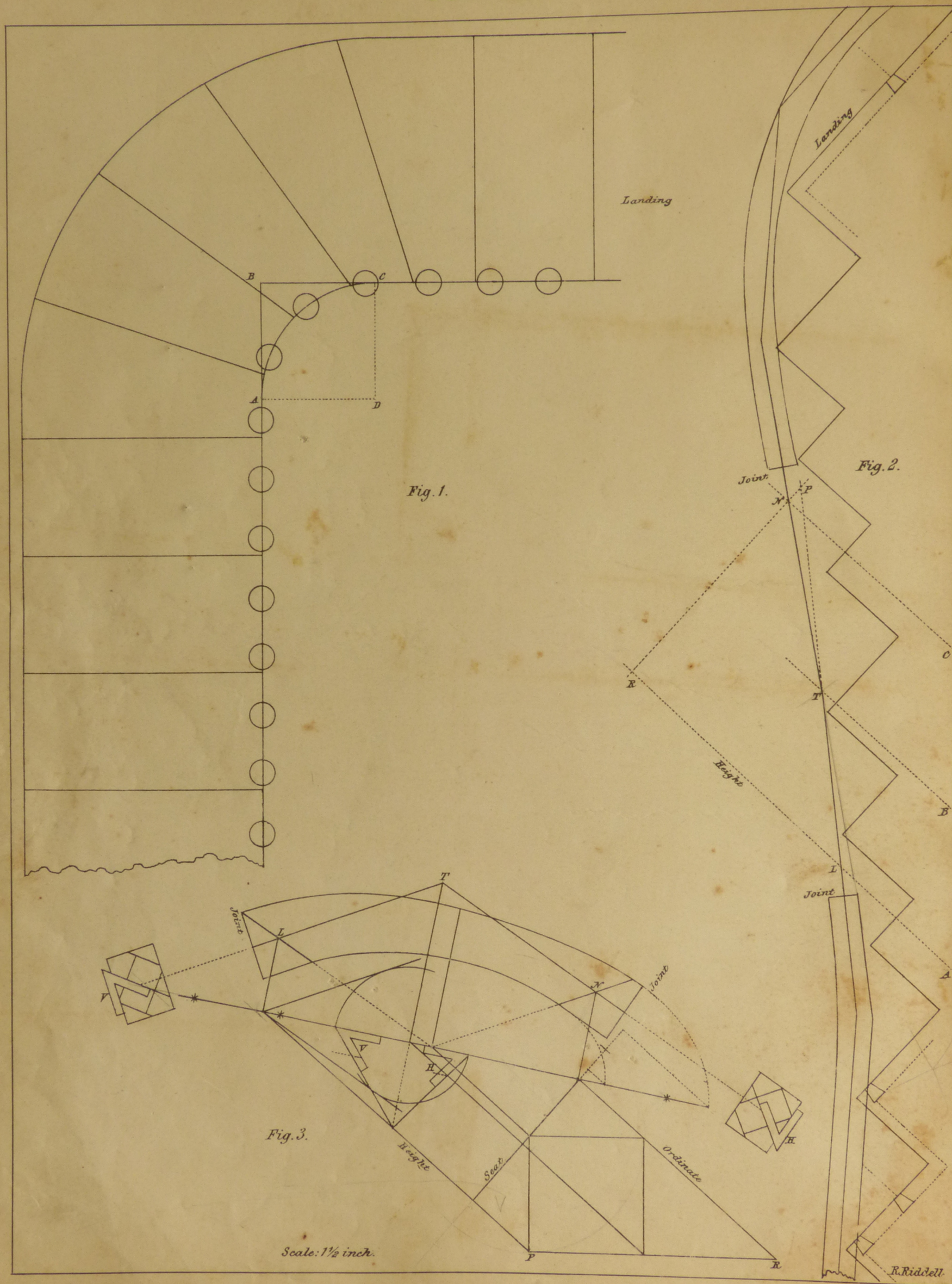


PLATE 23.

QUARTER-CIRCLE STAIRS HAVING FIVE WINDERS AND LANDING WITH ONE SQUARE STEP.

FIGURE 1 shows the ground plan. The rail on right going up stairs. The tangents form the right angle A B C.

Fig. 2 shows tangents, winders, and square steps unfolded.

The under side of level rail on the landing is raised to suit long baluster on square step.

The wreath over winders has unequal pitches: its upper part being T N; the lower, T L; its height, R L.

To find a direction for ordinate. Extend L T, cutting at P, which gives P R. Transfer this to extended side of square, Fig. 3, where corresponding letters are shown.

Let square equal that on plan. Draw ordinate. Make seat square with it. Let height equal that on right. Then draw pitch and construct mould as usual.

Tangents L, T, N, to be correct, must equal corresponding letters on pitch, Fig. 2.

Square sections show joints.

Stock of bevel H and that of V are on the surface of plank. The blades, in all cases, pass through half the width and half the thickness of rail. In other words, the tangents on mould being square across the joints, then half the thickness of plank marked gives a centre through which the bevels pass.

The accuracy of work depends entirely on the proper application of bevels, and the manner in which the joints are made. An error in either, renders it impossible to have a wreath stand correctly over its plan. This has been already remarked, and should be constantly kept in mind.

Nearly all the drawings are to a scale of inch and half to the foot, which gives the opportunity of clearly showing the meaning and intention of every line; particular pains having been taken, to make each plate its own interpreter, not depending solely on letter-press description.

PLATE 24.

CONSTRUCTION OF WREATH FROM RAKE TO LEVEL.

FIGURES 1 AND 2. These plans exhibit a straight flight of stairs, landing on a level floor. Both cylinders have equal diameters. That on right, shows face of riser standing on the spring-line, whilst that on the left, is made to stand back in cylinder.

This is all wrong; yet such mistakes do occur, even with practical men. The correct methods for position of risers on similar stairs, have already been given. But here an error has been committed, which must be covered by producing a wreath to stand over it; so that no imperfection shall appear in either rail or stairs. This will not be difficult when we have a system which applies, with certainty, to every situation; be it right or wrong.

Fig. 2. Line A B shows height of riser and A C the step. Let under-side of level rail be half a riser above landing. Set off thickness of rail from both rake and level, and draw lines intersecting at E. Square down from E, cutting at D. Let D L equal D A. Tangents are now in position for lower part of wreath. The line D L falls level, and A D stands on pitch V E. Square over V N. This gives N E for height.

Fig. 3 shows construction of mould. Let A, D, L equal tangents above. Draw L H extended and parallel with A D. Make H T, the height, equal that of N E above. Join A T extended. This line being both pitch and major axis, gives plain directions to strike mould, as shown.

This piece of wreath forms its own easing, similar

to that starting from a newel. Stuff for level piece should be a little thicker than that of the rail, say half an inch. This gives the opportunity of increasing the curve across joint on upper and lower side, and adds much to appearance of wreath.

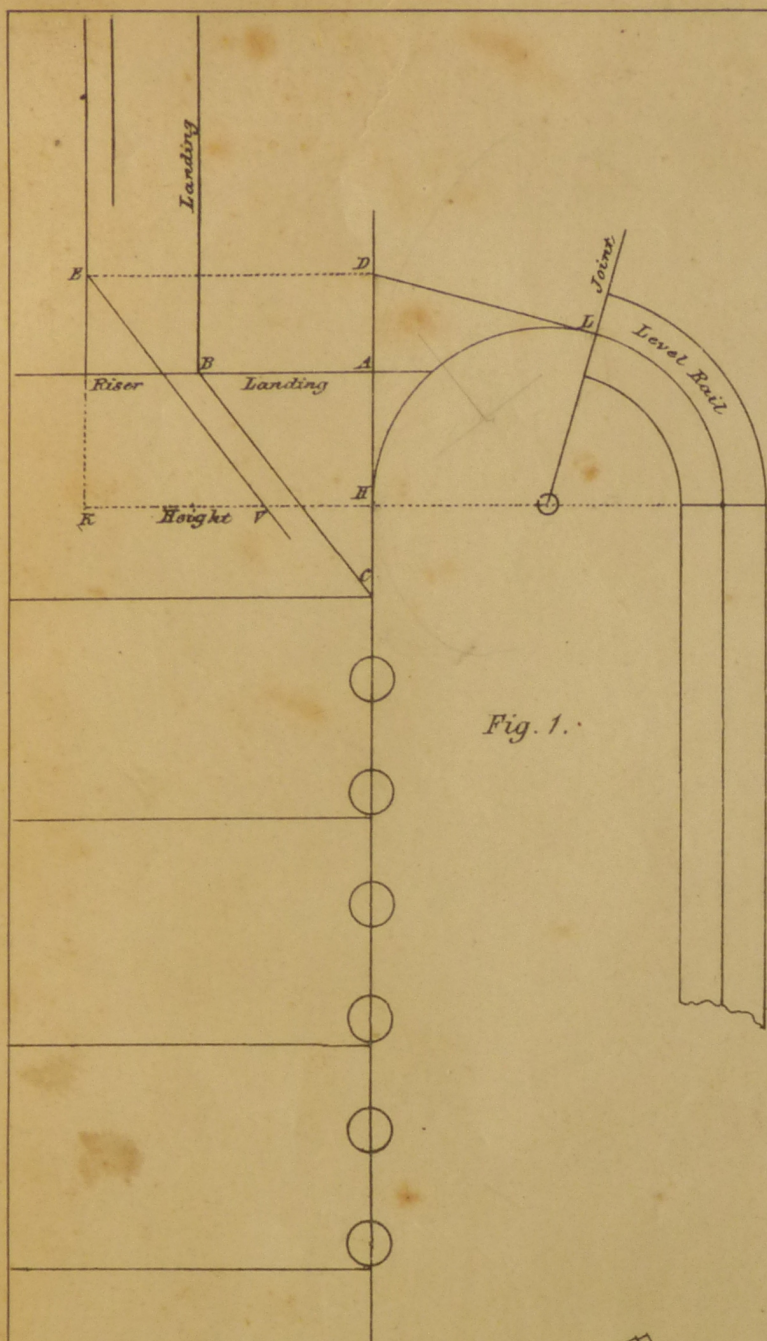
It is understood, however, that the additional stuff, being more than the thickness of rail, throws level that much higher. That being so, lower the height N E half an inch.

Referring to Fig. 1, it is seen that riser-landing stands in the cylinder. Height of level rail is the same as that on right. The letter E shows intersection made by pitch and level. Perpendicular E D gives H D, and D L for tangents. Letters K V show height of wreath, and K E the ordinate.

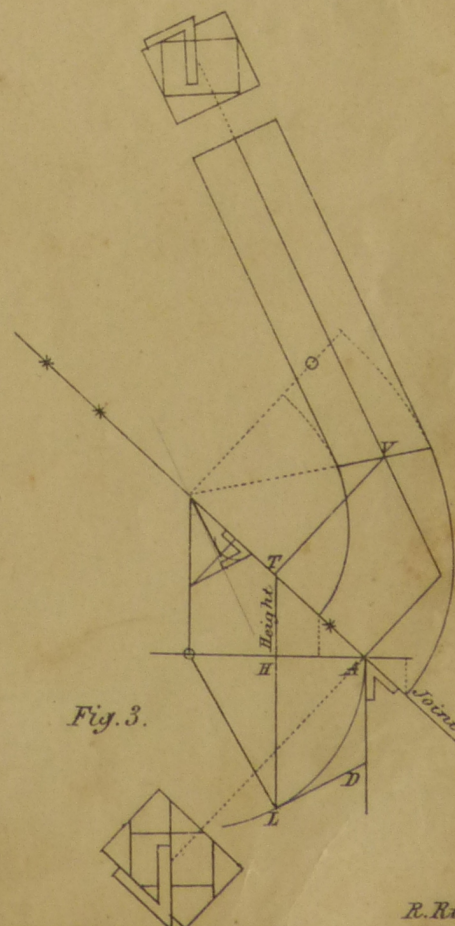
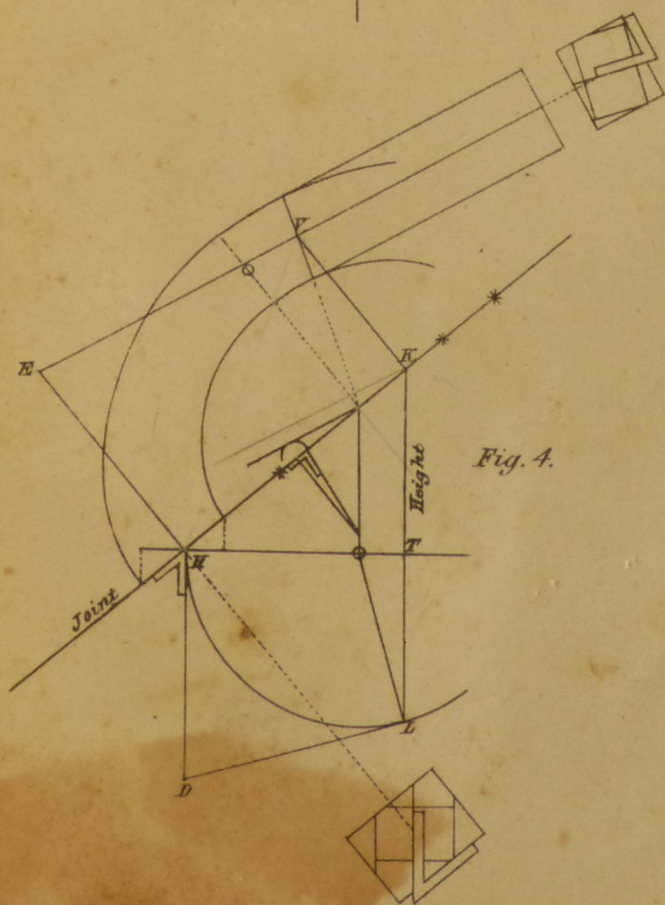
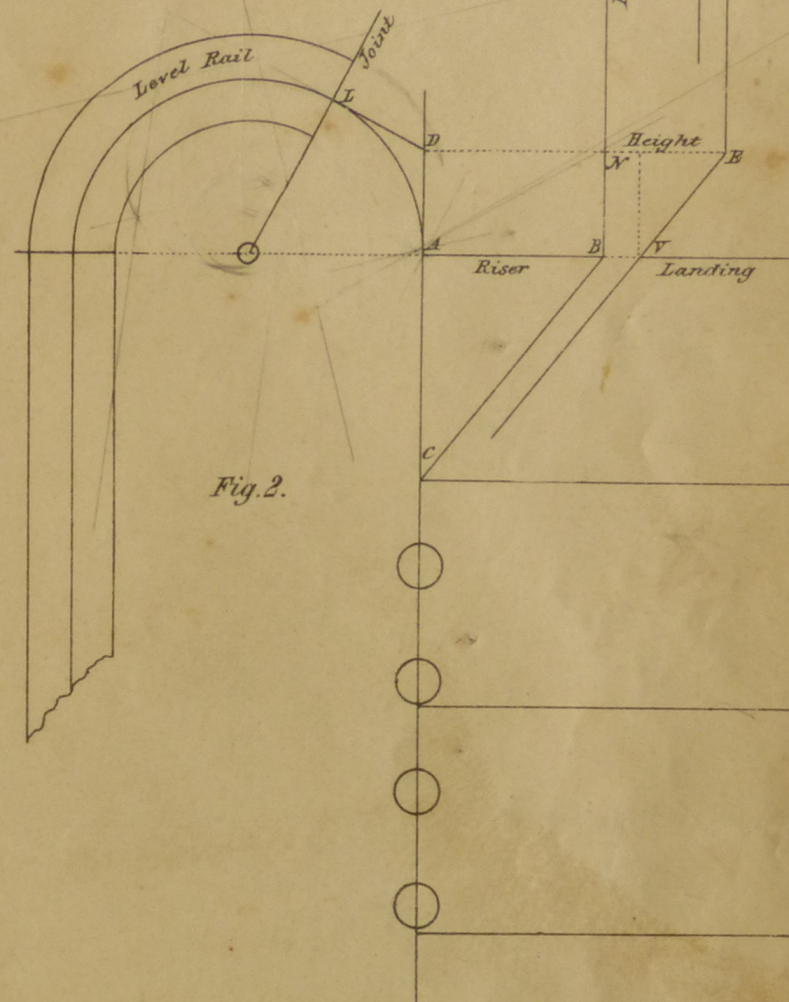
Fig. 4. Let H, D, L equal tangents above. Draw L T extended and parallel with D H. Let T K, the height, equal that of K V above. Join H K extended. Next, square over K and H. Let K V equal T L, and H E equal H D. Join E V extended. This line, to be correct, must equal that of V E above.

To find width of mould on wide end.

Set off half width of rail on each side of H. Then draw parallel with H D to cut pitch. Now find points to insert pins and strike the mould. Observe that the tangents at Fig. 1 throw the joint past centre. This gives to the lower piece of wreath sufficient easing. Then, the level part connecting with it remains the same thickness as that of straight rail.

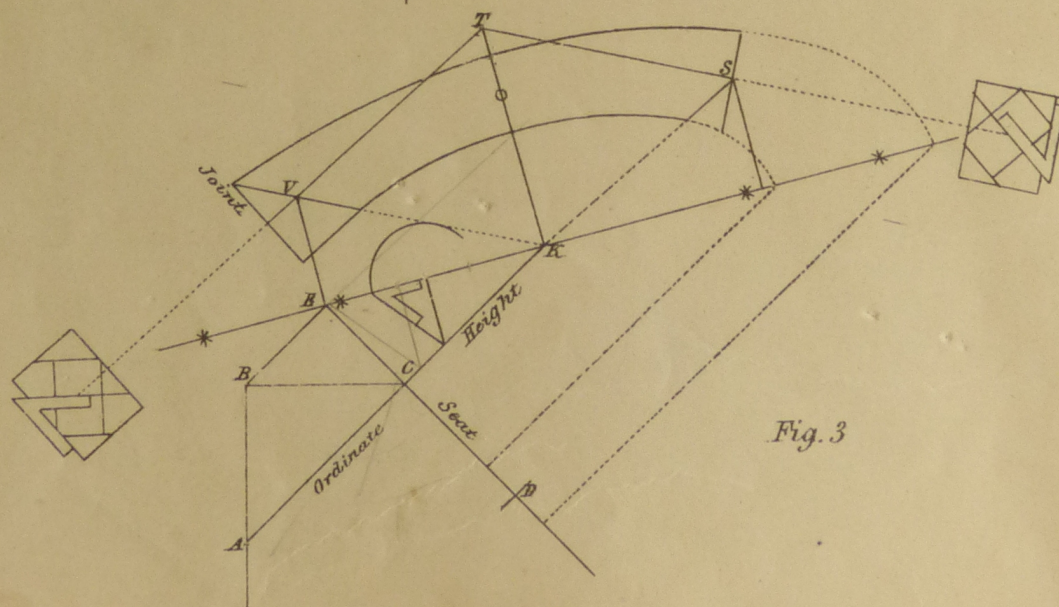
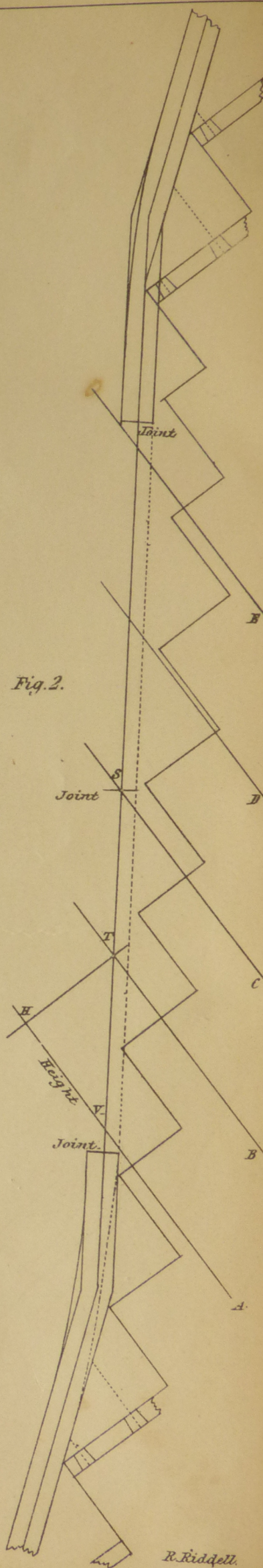
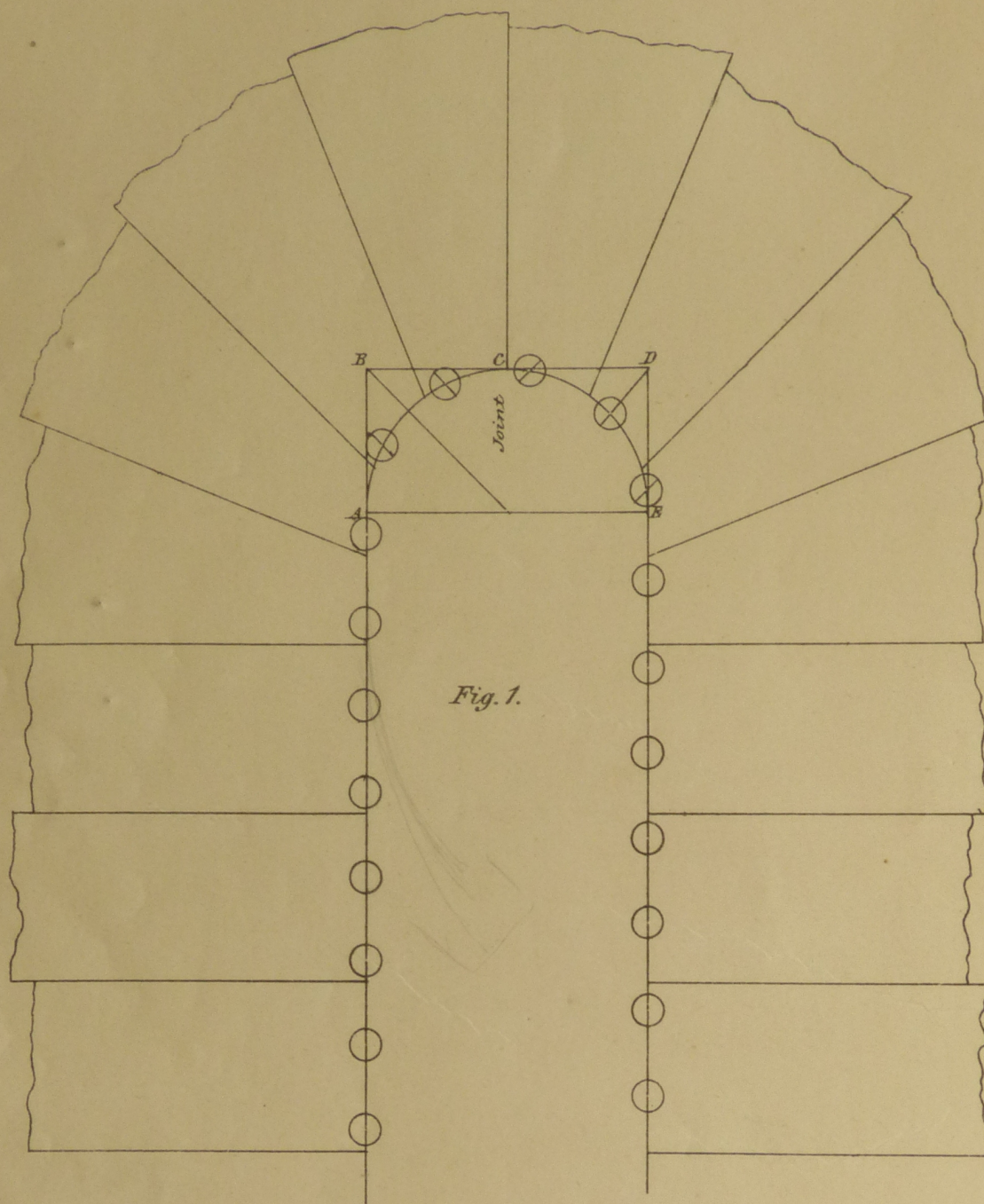


Landing



Scale: 1 1/2 inch.

R. Riddell.



Scale: 1 1/4 inch.

R. Riddell.

PLATE 25.

CONSTRUCTION OF SEMICIRCULAR STAIRS HAVING EIGHT WINDERS.

FIGURE 1 shows ground plan. Circle, or centre line of rail struck with a radius of eight inches. Narrow end of winders equal to half a square step.

Enclose circle with tangents A, B, C, D, E. These having cut the winders, give a direction to unfold them, measuring on tangent lines, and not on the circle.

Fig. 2 shows tangents and winders spread out. Letters along the margin correspond with those on plan. Adopt the same method as that for laying out a string. The object being to find pitch and height of wreath over winders. Also, of lower and upper ramps.

Let square steps stand in same position as those on plan. Have lower side of rail rest on corners of square steps.

Set off half its thickness. This gives direction to draw pitch, cutting through S, T, V. Being a straight line makes the pitches of wreath equal, and construction of mould simple.

The lower and upper part of wreath are equal heights. Centre joint is at S. Then H V shows half the height between V and S.

Fig. 3 exhibits construction of mould. Commence

by making two sides of a square. Let A B C equal corresponding letters above. Join A C extended. This is ordinate; being the diagonal of a square. Draw from B, parallel with ordinate. Make seat square with it. Let C K, the height, equal that of H V on the right. Join E K extended. This is pitch and major axis.

To find points for striking curves: Let D C equal C B. Set off on each side of D half width of rail. Square up to cut the pitch.

The most practical way is: Have a piece of board suitable for mould. Lay it on, and mark E K. Let distance on right equal E K. Square over lines. This done, run a gauge, say an inch from the edge. Then let E V and that of S, equal E B. Make K T equal C A. Join S T and T V extended. These are tangents on mould; and to be correct, must equal pitches on the right.

Next, let K O equal B C. Then set off on each side of O half the width of rail. All is now ready to sweep the mould with a string.

Pitches being equal, one bevel answers for joints; as the application shows.

PLATE 26.

DESCRIPTION OF SEMICIRCULAR STAIRS HAVING ALL THE WINDERS TENDING TO A CENTRE.

CORRESPONDENTS frequently write for information in regard to construction of wreaths for stairs which have been prepared and fixed without any attention to position of risers in cylinder.

This, and the two following plates, are copies selected from many plans of stairs which have been sent to me, with a request to make drawings for wreaths. In complying, we may, at the same time, point out some defects on the ground plans, and show how a better arrangement could have been made.

The first example is that of Fig. 1. Here the diameter of circle is eighteen inches; and narrow end of winders less than four, whilst that of preceding plate shows the circle to be only sixteen inches. Yet the narrow ends of winders there are two inches more than here. Which at once shows this plan defective in arrangement. The last step-landing should have been square, and winders thrown past the spring line below A. Then the ramps connecting with wreath would have improved curves, and make the rail a more uniform height over winders than it is possible to do here; which will be presently seen.

Fig. 1. Let circle be enclosed by tangents. These unfold on a board, as shown at Fig. 2. The letters along the margin on right, correspond with those on plan. Now transfer position of winders, cutting tangents on plan, to that of Fig. 2. This done, set off two square steps. Let under side of rail rest on corners. Set off half its thickness. Next, let level

rail stand above landing to suit a long baluster. You are now ready to draw pitches over winders.

Assume the first pitch; say 2, 3, the next 3, 5, and 5, 6, for the upper. All these pitches are unequal, yet the best that can be done for stairs arranged as these are.

The winders show the wreath too high at intersection 5. But, to lower it would destroy the ramp-landing, and make its curve short and abrupt.

The height for upper part of wreath is P 4, and P N direction for its ordinate.

The height for lower part of wreath being K 2, and K R direction for ordinate. Fig. 3 shows construction of mould.

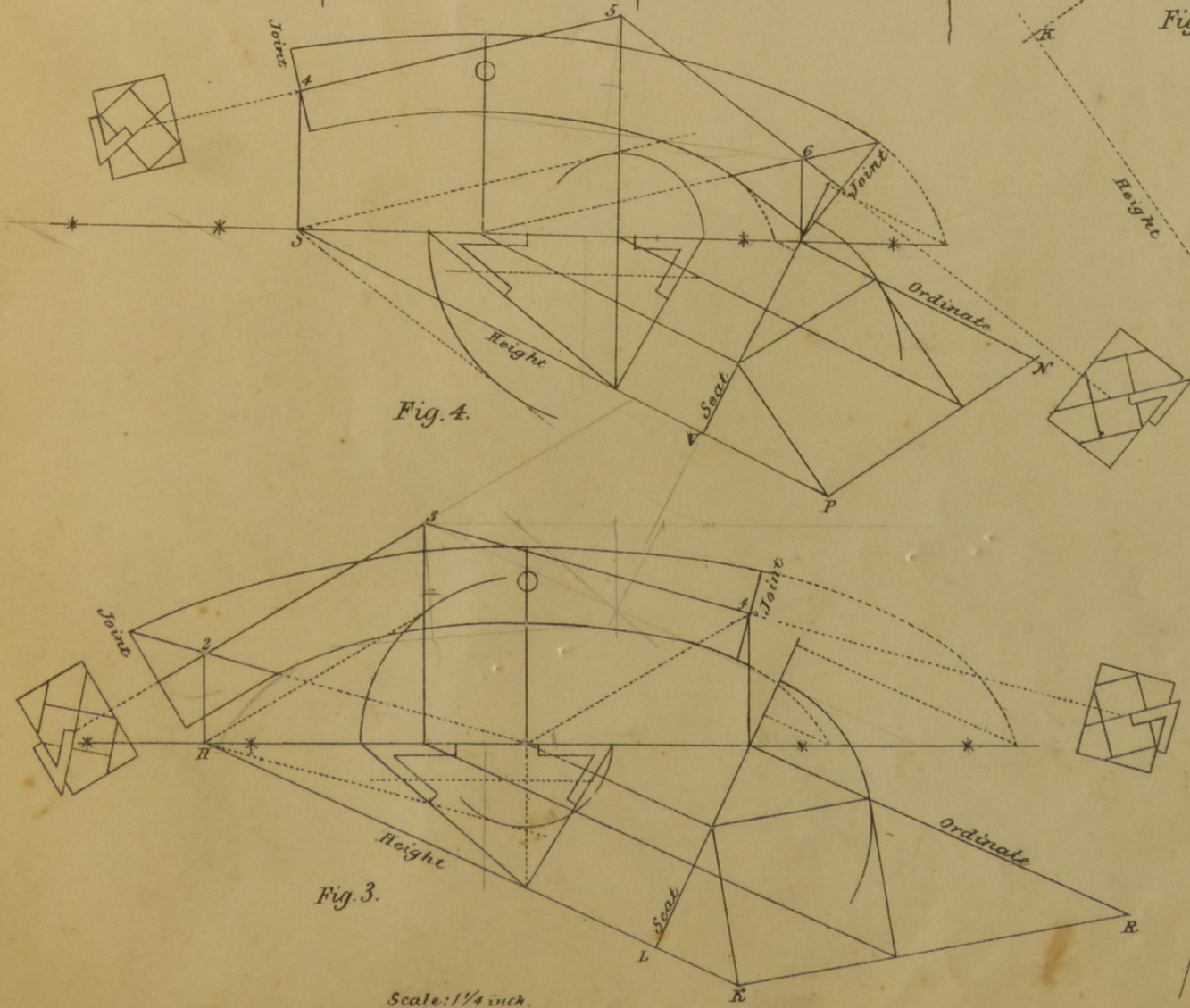
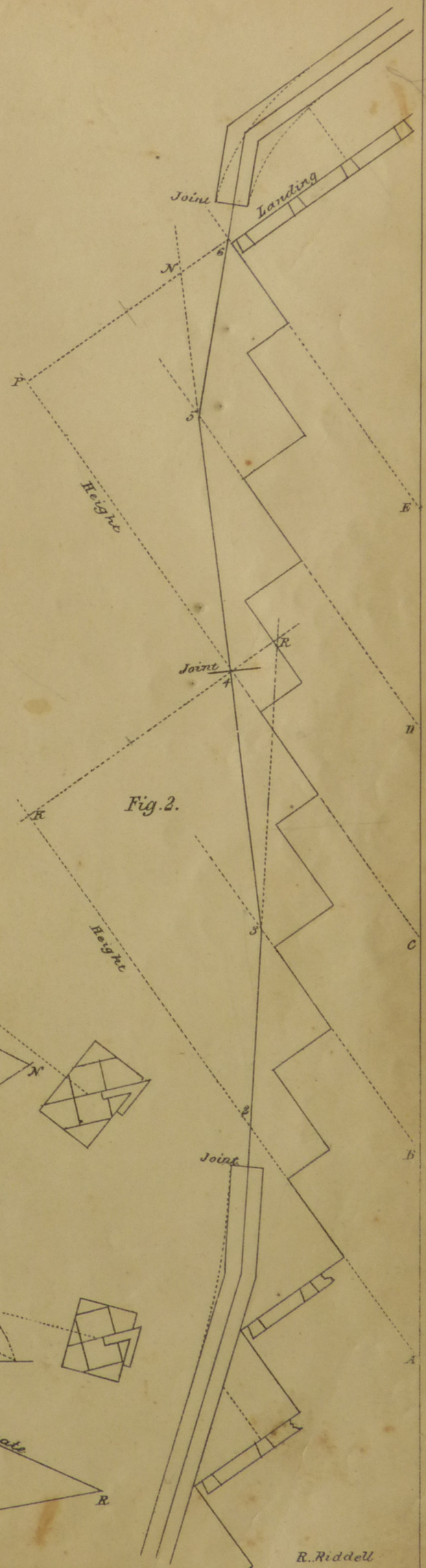
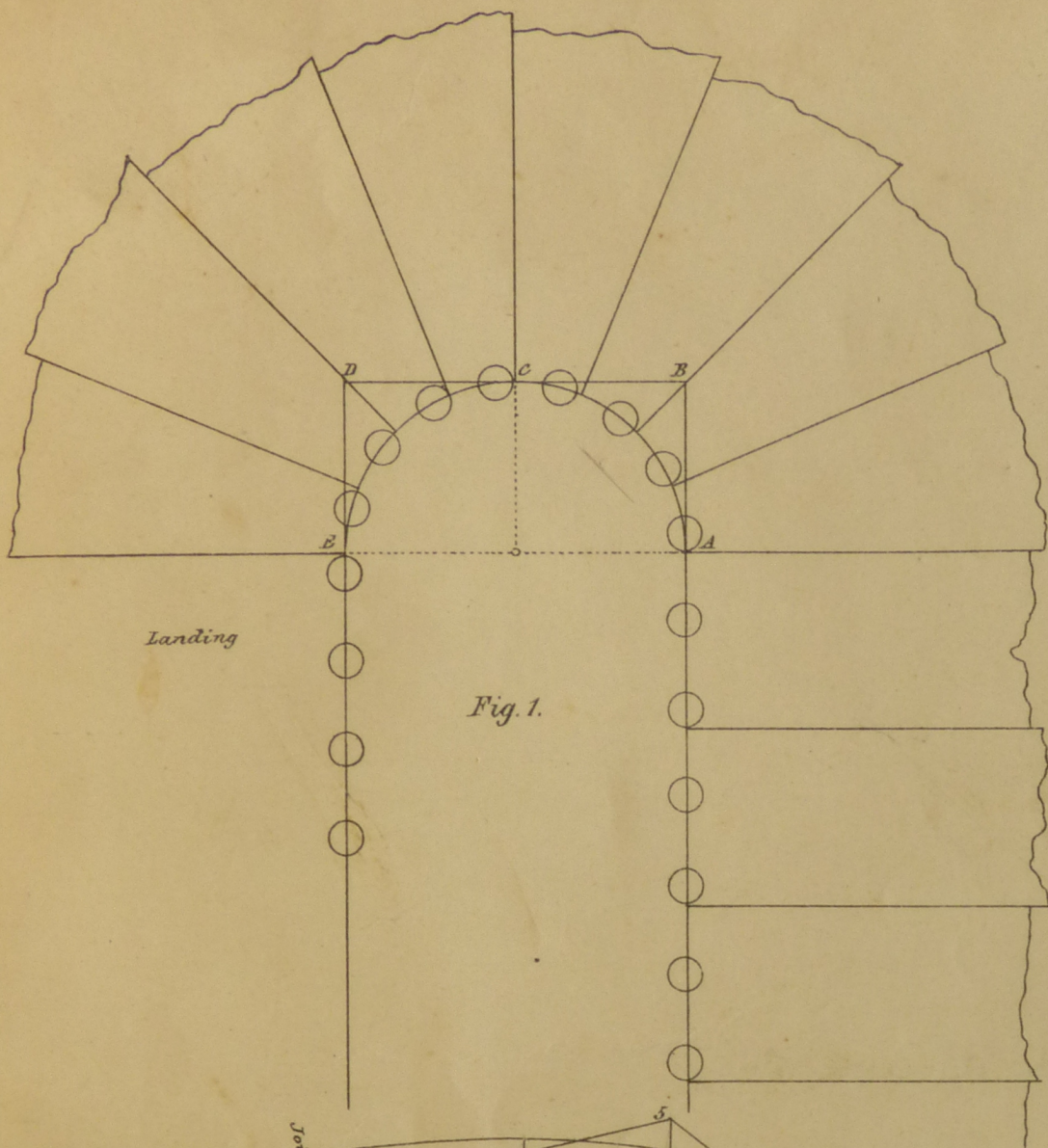
Let the square equal one of those on plan, and K P equal corresponding letters on right. Draw ordinate. Make seat square with it.

Let height L H equal that of K 2 on right. Now draw pitch and strike mould, as usual.

Tangents 2, 3, 4, being equal to those on pitches, proves the correctness of drawing. The square sections show joints and application of bevels.

Fig. 4 is the mould for upper part of wreath. Let extended side of square P N equal corresponding letters above. Draw ordinate. Let seat be square with it. Make height V S equal that of P 4 on right. Next, draw pitch, and you are ready to strike the mould.

See that tangents equal those of pitches on right.



Scale: 1/4 inch.

R. Riddell

Landing

Joint

Fig. 1.

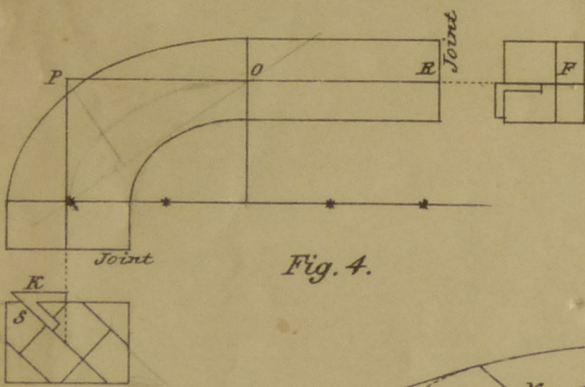
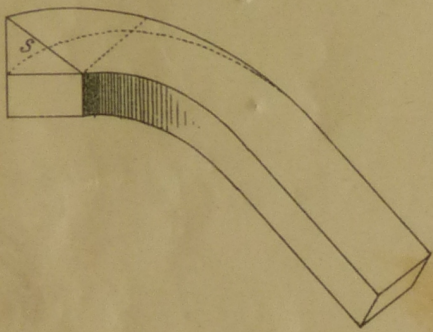


Fig. 4.

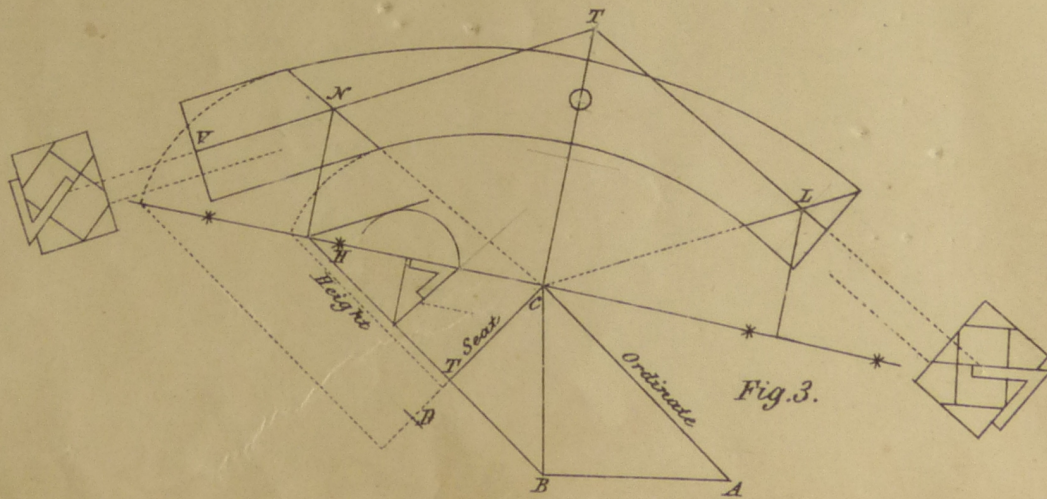


Fig. 3.

Scale: 1 1/2 inch

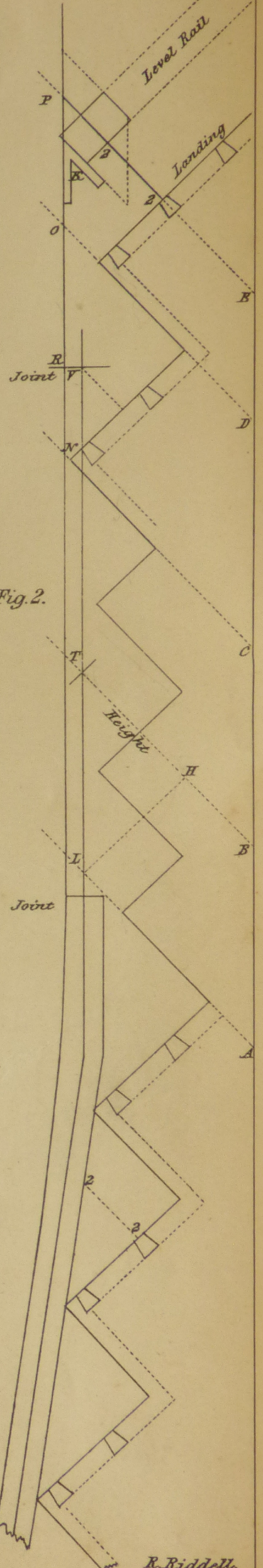


Fig. 2.

R. Riddell.

PLATE 27.

DESCRIPTION OF STAIRS HAVING THREE WINDERS IN THE QUARTER CIRCLE AND LANDING, WITH ONE SQUARE STEP.

FIGURE 1 shows a stairs, the plan of which is anything but good. The arrangement should be five, or even six winders, and no square step landing.

This would cause less space for the run, and throw the newel farther into the hall — a very important matter in some situations, especially so, when the space is very limited. But the stairs are fixed, and no alteration can be made. The wreath is quite simple, and is easily constructed. Let tangents which enclose circles be unfolded on a board, as shown at

Fig. 2. The letters along margin correspond with those on plan.

Let winders here stand in the same position as those cutting the tangents on plan.

Have level rail stand above landing to suit long baluster on square step. Letter E on the right indicates corner of small square on plan. Then line EP is centre of rail. Set off half its width on each side of P. Now form square section, and show width and thickness of rail. This done, draw the pitch from corner of section to cut upper side of ramp at L. Next, set off half thickness of rail. Then find half the height of wreath between L and N by squaring over LH, which gives height HT. We are now ready for the mould.

Fig. 3. Let A, B, C equal corresponding letters on plan. Join AC, the ordinate. Make seat square with it.

Next, draw from B parallel with ordinate. Let TH, the height, equal that of HT on right. Join

HC extended. This is both pitch and major axis. Find elliptic curves cutting pitch by making CD equal CB. Set off on each side of D half width of rail. Then square up the lines; which gives the point required. Have the board ready for the mould. Lay it on, and mark the intersections on the pitch, as shown.

Find points to insert pins. This done, strike the mould with a string.

The straight shank may be any length desired, say NV. Transfer it to Fig. 2, where corresponding letters are shown. Draw joint V, which gives RO for straight shank of upper piece of wreath. Fig. 4 shows mould for this. The drawing is simple. For example: Take a piece of board, and run a gauge line, say three inches from edge. Set off a distance to equal ED, shown on small square above.

Next, square over a line, say that through O. Set off on each side of O half width of rail. Let P, O, R equal corresponding letters on pitch to the right. Let wide end of mould and bevel K, equal that given by square section, cutting pitch at P, also on right. Now find points to insert pins, and strike the mould.

The square section on the left shows the end joint at landing. Slab S, on upper side, being cut off square with joint, as shown.

Concave side on upper corner makes the easing. Square section on right shows the slab F. This is cut off the lower surface of shank.

PLATE 28.

CONSTRUCTION OF SIDE-RAIL PROJECTING FROM CIRCULAR WALL, RESTING ON IRON BRACKETS.

FIGURE 1 shows stairs starting with four winders. Let rail project two inches from wall.

Set off half its width. Divide A E in two equal parts. Then mark joint C.

Next, draw tangents A, B, C, D, E. See that these are of equal lengths.

Let C, D, E be unfolded, as shown at Fig. 2. The letters along margin correspond with those on plan.

Set off two square steps. Have riser J stand in same position as that on plan.

Let under side of rail rest on square step, also on corner of tangents opposite C and D. Set off half its thickness and form the ramp. The pitch over winders, and that on square steps, intersect at T, which shows that tangents on the mould must be equal, and its ordinate a right angle to chord A C on plan.

Fig. 3 shows construction of mould. Let tangents A, B, C equal those on plan. Draw line A C. Make ordinate square with it. Have seat parallel with A C. Let height L P equal one riser. Join R P extended; this being the pitch. It also gives direction to draw the mould; which may be done by ordinate, as shown for small curve.

Or, it may be struck with a string, if the latter method is adopted. Then the major axis is found by making P 4 equal L B, and square with P R. Extend line from P, and let 4 O equal O B. Then draw through O parallel with pitch R P.

To find the length of elliptic curves:

Draw from O parallel with seat. Let O V equal O O. Set off on each side of V half width of rail. Then square down, cutting at K and N. Next, find points on major axis to insert pins. This done, lay a piece of board on and strike mould.

Tangents 3, 4, 5, and small curve, give the mould for lower piece of wreath, while 2, 4, 5 is that for upper piece.

Have line through 5 marked on under side. Now slit mould through half its thickness, thus making two.

Cut off at 5, and square with 5. 4. Let joint 2 be square with 2. 4. This completes the mould for upper piece of wreath.

Bevel K applies to all the joints, except that on small circle; its joint being the dotted line from 6 parallel with 5. 4. It will be best, however, for application, to draw from 6 parallel with R P. Then the bevel H applies to edge of plank, and directs application of mould. Let the slabs be taken off both sides before cutting off the dotted line. It being the joint against the plastering.

Drive a plug and fasten with a hand-rail screw. This is much neater than breaking the plastering and wedging the rail.

The situation of square step on plan happens to be right to make the pitch a straight line over the winders. But, in case the step is not in the right position; then make upper piece of wreath have two different pitches, to suit the ramp.

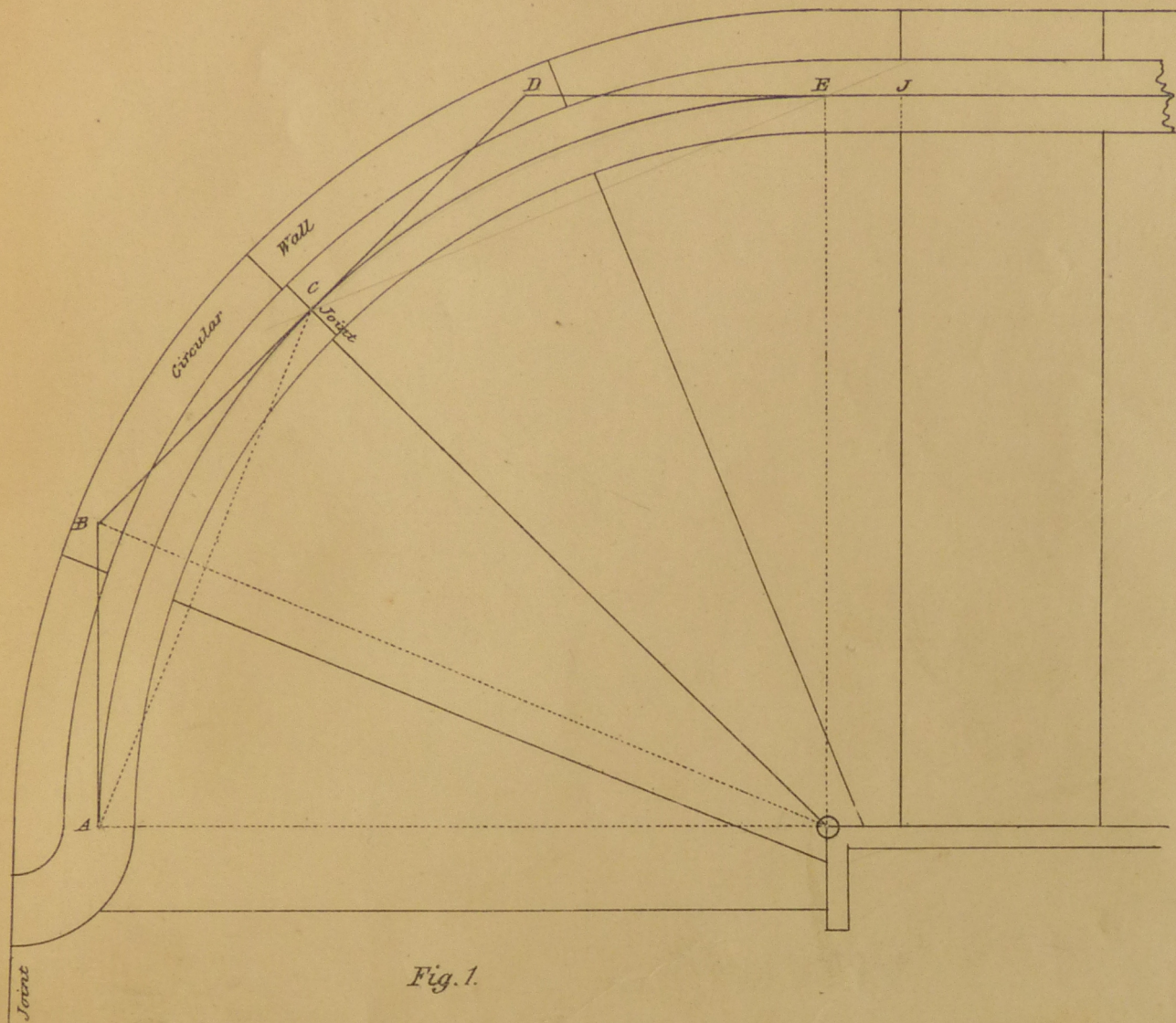


Fig. 1.

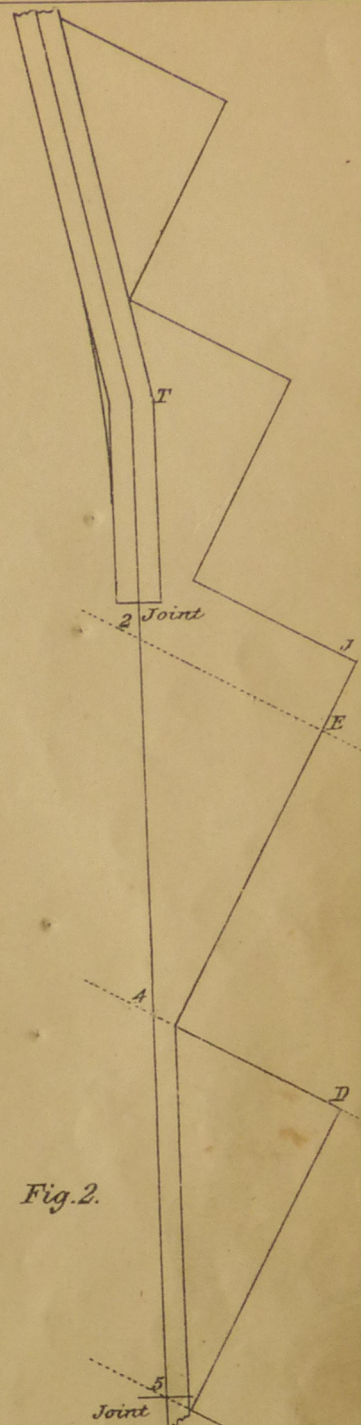


Fig. 2.

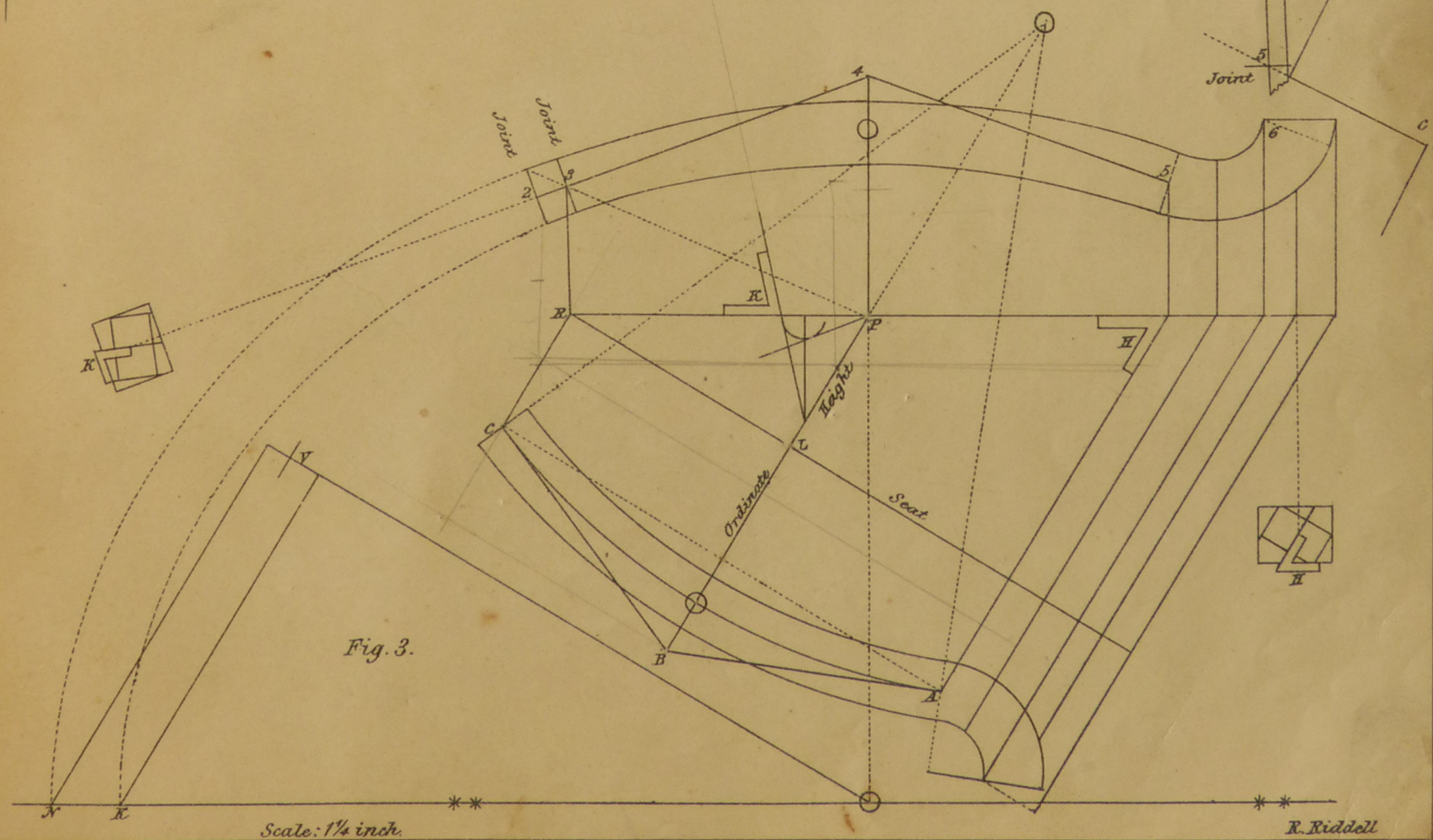
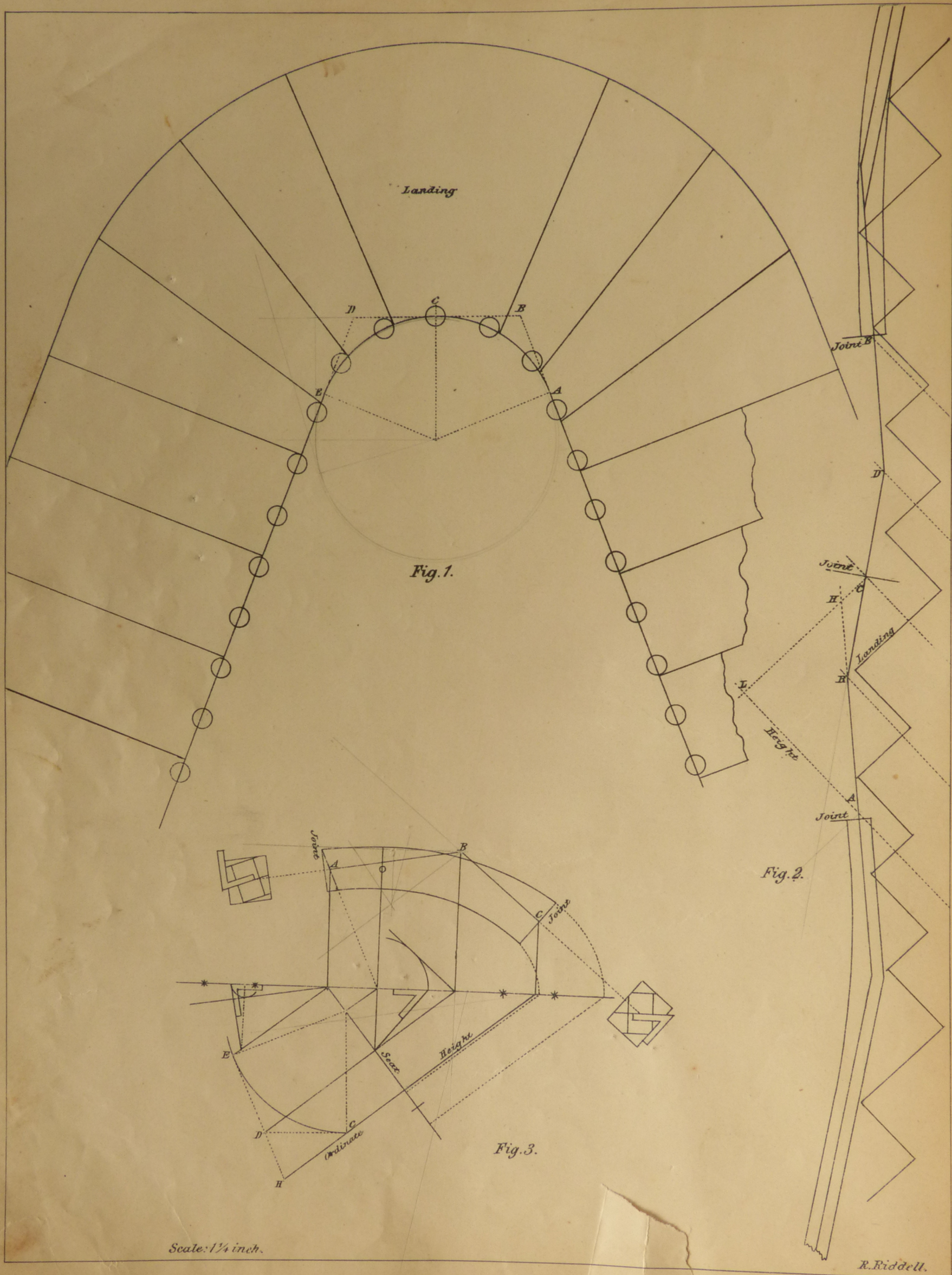


Fig. 3.

Scale: $1\frac{1}{4}$ inch.

R. Riddell



Scale: 1 1/4 inch.

R. Riddell.

PLATE 29.

CONSTRUCTION OF WREATH FOR STAIRS WHICH STAND ON ACUTE ANGLE, HAVING A LANDING TO GIVE ACCESS TO A DOOR OR WINDOW.

FIGURE 1. When the ground plan of stairs makes either obtuse or acute angles, adopt the same process for the construction of the mould as if the strings were parallel.

For example:

The centre line of the rail is enclosed by the tangents A, B, C, D, E. Now let these be unfolded at Fig. 2. Have the winders to stand in the same position as those on plan. Also the square steps. Draw the pitches and ramps, as shown. Be careful to have that of D E parallel with A B, in order that one mould may answer for both pieces of wreath.

The letters on the pitches agree with those on the ground plan.

Find height and direction for ordinate by squaring over from joint C, cutting at L; which gives

A L for height. Next, extend A B, cutting at H. This gives L H as direction for ordinate.

We are now ready to draw the mould as shown at Fig. 3.

Let the tangents C, D, E equal those on plan. Let E H equal L H on the right. Join H C extended. This gives the ordinate. Draw from D and E parallels with it. Make seat square with it. Let height equal that of A L on the right.

Draw the pitch and complete the mould, as usual. See that its tangents A, B, C agree with corresponding letters on pitches to the right.

Stairs of this form are often seen in London, Paris, and other cities of Europe, as well as in this country; and where necessity of location demands such a plan, the method just given may be adopted for its construction.

PLATE 30.

OUTSIDE STEPS AND RAILS FOR PORCH OR VERANDA.

FIGURE 1 exhibits the ground plan. Risers curved. Hand-rails six inches wide. Side curves not limited to any particular radius. For example: Assume line A O for radius. This gives A, B, C for tangents. That of B C falls level when in position. It is also the ordinate.

Remember the statement concerning the height of newels being regulated and determined by the situation and length of tangents on ground plan. This drawing further illustrates that point. For example: Suppose the angle of tangents, meeting at B, removed to the second riser; and the under side of rake-rail to measure two feet from top of step, and on a line with face of riser. Then it is clear that the height of newel is two feet seven inches from top of first step to under side of mitre cap. Riser being seven inches.

This is fully explained at Fig. 2, where tangent A B and steps, are unfolded the same as those on plan.

Let under side of rail rest on square step. Set off half its thickness, cutting at L. Now observe the space between top of first step and under side of cap. This being added to height of rail, gives that of newel. Tangent A B has determined this point.

Find the height of wreath by squaring over A B. Fig. 3 shows the construction of mould.

Commence by making the right angle O A B to equal that on plan; having corresponding letters.

Let B C equal B A. Draw from C parallel with B A. Let K N, the height, equal that of B L on the right. Join A N extended.

Next, make O T parallel with C K. This done, square over T N A. Let A E equal A B. Make N L equal K C. Join E L. This line, to be correct, must equal pitch A L on the right. Let T V equal O C. Set off on each side of V half width of rail. Set off the same on each side of A.

Now find points to insert pins, and you are ready to strike the mould.

The bevel at N is applied to square section on the left. The projection of straight wood below A is equal to the mitre on the square cap.

This problem will be valuable to the mason who operates in stone. The rail being worked out of one block; it forming mitre, cap, and ramp.

To find the thickness of stone:

Let R K be the face of wall. Then make L P equal B D, Fig 1. Draw P R so as to leave a curve on the ramp. Then draw H K parallel with it. This gives ten inches as the thickness.

The mould for this must be constructed to suit the pitch P R; and the line A L remains in its present position; that being the centre of wreath.

To curve risers:

Make two plough-grooves on the back, say $1\frac{1}{2}$ inches from edge. Then kerf.

Have two ribs made to the required curve. Force them into the plough-grooves.

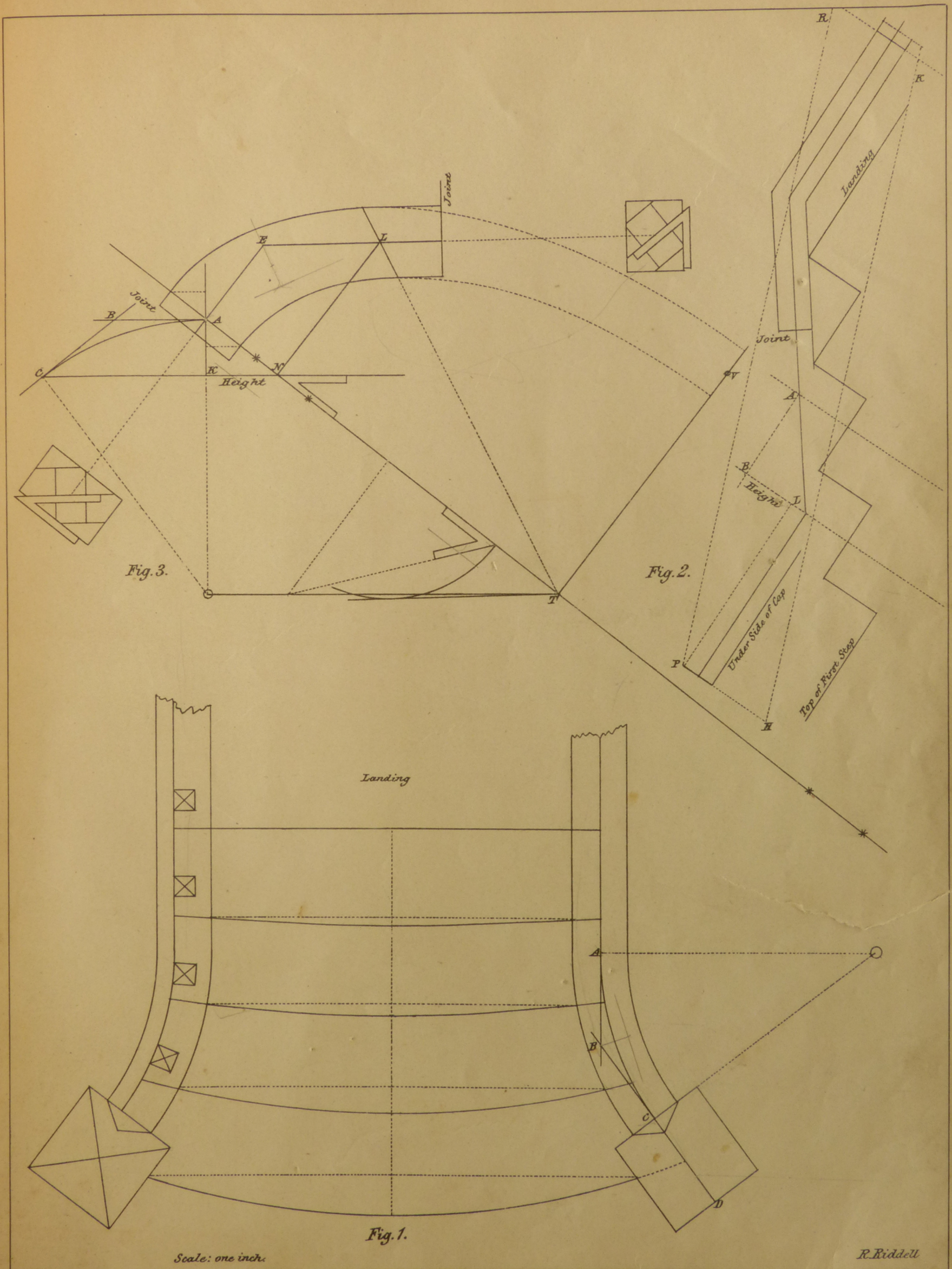


Plate 31.

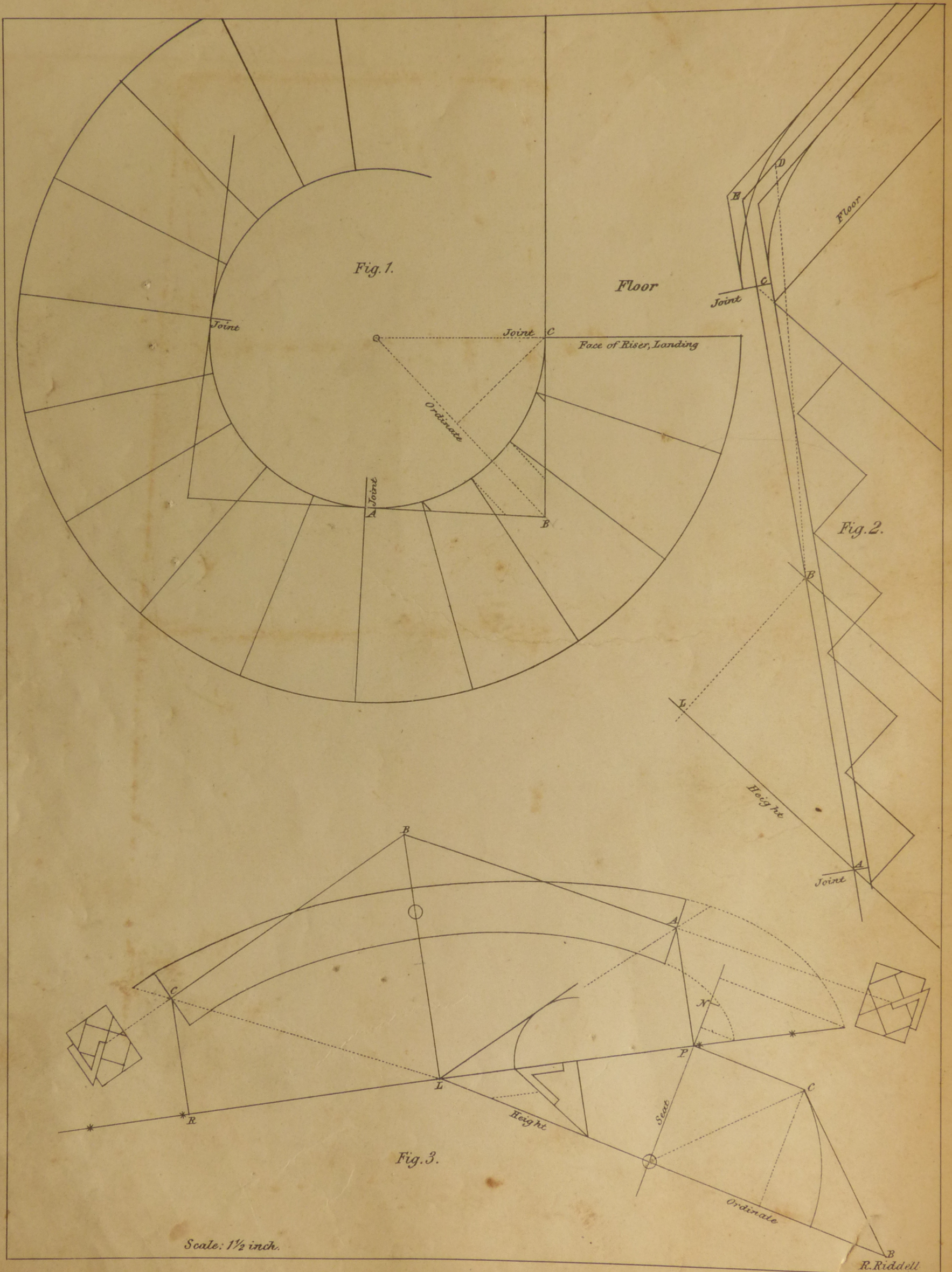


PLATE 31.

THE WREATH AND RAMP AT LANDING OF CIRCULAR STAIRS.

THE rails for circular stairs require more than ordinary care in their construction.

If either joints or curves are incorrect, such errors may not be noticed until the work is fixed. Then the eye instantly detects a deformed and irregular curve; which is at once condemned as unworkman-like, and unfit for use.

There are four different positions at the landings of circular stairs; the wreaths for which have been considered difficult. This system, however, makes the construction perfectly simple.

The first example is that shown at Fig. 1.

The straight rail on the floor has a ramp connecting with wreath landing. The joints are made so that each piece stands over five winders. The tangents are drawn through centre of joint A and C, and intersect at B. The pitch of rail being a straight line, makes the ordinate B O.

It matters not what angle the tangents make, a line drawn from their intersection to centre of plan is always ordinate. That is to say, when the pitches are equal — as in this case they are.

Draw lines from intersection of winders and centre of rail parallel with ordinate, cutting tangents.

Unfold A, B, C, and position of winders on tangents, as shown at Fig. 2. Let under side of rail rest on risers A and C. Set off half its thickness. Then set off under side of rail above floor, say six inches. Assuming short balusters on winders 2-2. Then the centre of rake and level rail intersects at E. This forms the ramp. Its curve could be improved by changing the pitch to B D.

In that case a separate mould would have to be made. Let the present position be considered as fixed.

Find half the height of wreath between A and C by squaring over B L, which gives L A. We are now ready to draw the mould. Its construction is shown at Fig. 3.

Commence by drawing a straight line in any direction; say that marked "Ordinate and height." Take any point; say O. Square over seat. Let O, B, C equal corresponding letters on plan. Draw C P parallel with ordinate. Let O L, the height, equal that of A L on the right. Join P L extended. Make L R equal L P. Square over the lines. Let P A and R C equal P C. Make L B equal O B. Join A, B, C. These lines, to be correct, must equal the pitches at Fig. 2.

Next, find length of elliptic curves by extending the seat.

Let O N equal O C. Set off on each side of N half width of rail. Then draw parallel with ordinate, cutting the pitch.

Next, let L O, on line L B, equal O C. Set off on each side of O half the width of rail. This done, strike mould with either trammel, straight edge, or string. The last, of course, preferred, because the quickest. The application of this mould is: Let bevel lines, shown on square sections, be marked on both surfaces of stuff, and square with the joints. Then lay the mould on, and have A B and B C stand over those on surface of stuff.

PLATE 32.

CONSTRUCTION OF WREATH LANDING ON CIRCULAR STAIRS.

FIGURE 1. The position of this landing shows that the level rail must be continued around the curve. Fix upon the joints, say A and P. This leaves two risers from joint A to the floor. Draw tangents P H and H A extended. The length of A B is unknown until the tangents P, H, A and winder, are unfolded. This is shown at—

Fig. 2. Letters P, H, A stand in same position as those on plan. Winders in like manner. The rail on pitch and level have intersected at C.

The perpendicular from C gives A B, which transfer to tangent on left. Draw from B touching circle at N in such manner as to make seat N O square with N B.

Fig. 3 shows construction of mould for wreath landing. The line B N gives ordinate.

Draw from A parallel with it. Let D L, the height, equal that of B C on the right. Join N L extended. Square over lines. Then let L A equal D A. Make N C equal N B. Join A C. This line, to be correct, must equal pitch A C on the right.

Complete the mould as usual. Its application is to keep the joint N fair with that of the stuff, and

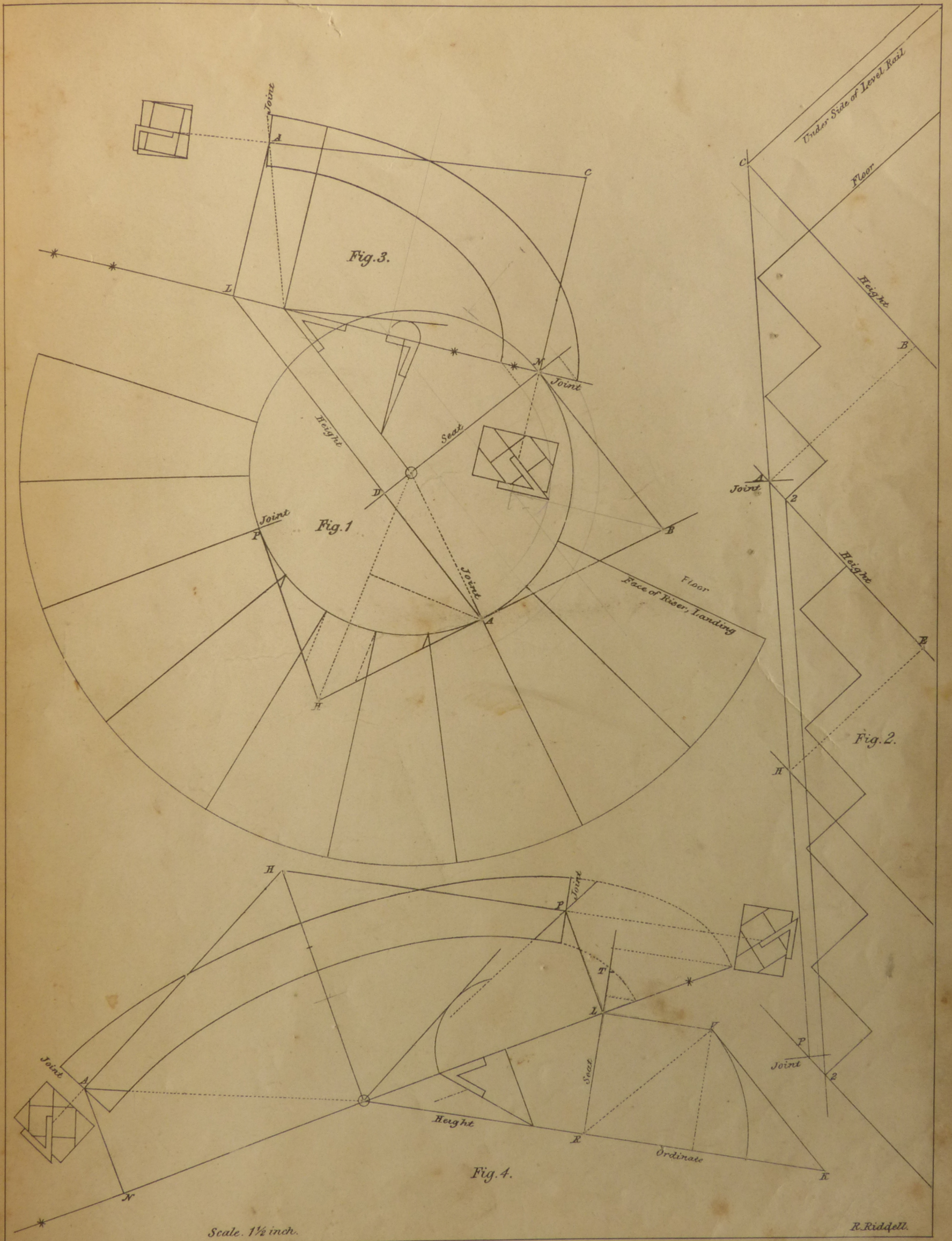
line N C stand opposite that made by bevel shown on square section.

Fig. 4 is the mould for piece of wreath to stand over five winders, and joins that on the landing. The construction being a repetition of that given in preceding plate. For example: Draw a line in any direction, say that marked "Height and ordinate." Take any point, say R. Square over the seat.

Let R, K, V equal O, H, A on plan. Make V L parallel with ordinate. Let R O, the height, equal that of A E on the right. Join L O extended. Make O N equal O L. Square over the lines. Let L P and N A equal L V. Also make O H equal R K. Join A H and H P. These lines must equal pitches on the right having corresponding letters.

To find the length of elliptic curves: Let R T equal R V. Set off on each side of T half width of rail. Then draw parallel with L V cutting pitch. Find the points to insert pins, and sweep the mould with a string.

Observe at Fig. 2—The under side of rail rests on risers 2.2, and covers five winders. This being the pitch, it gives the heights, and a proper direction for the construction of moulds.



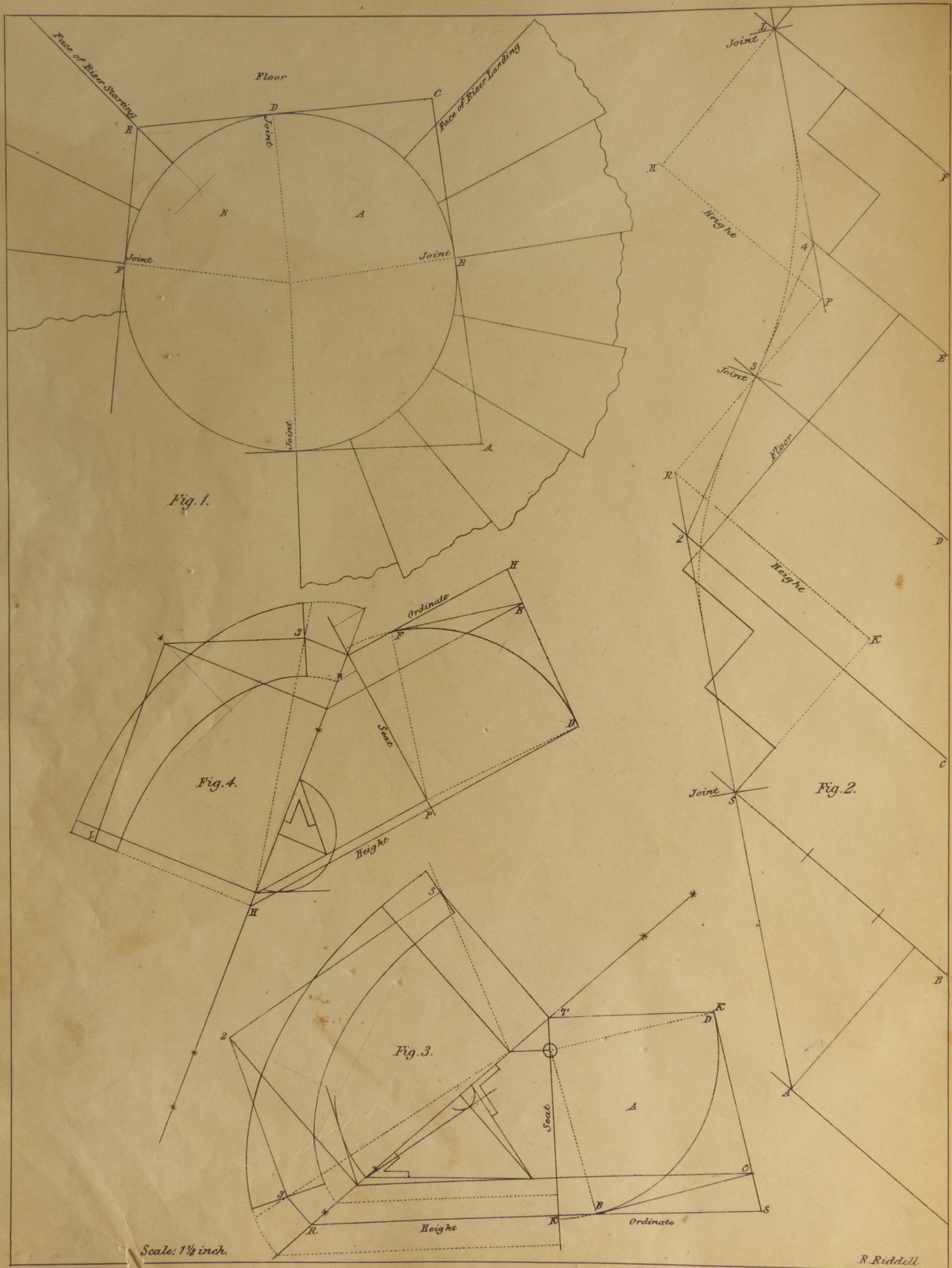


PLATE 33.

CONSTRUCTION OF WREATH LANDING AND STARTING FOR CIRCULAR STAIRS.

THE wreath is often made to present a most wretched appearance, by having a portion of it fall level: which should not be the case, unless the riser landing and that starting stand very far apart. This is seldom the case.

Any one knows that if a rail be continued from story to story, its pitch over the winders meeting that on landing causes a broken and crippled appearance, and seems like two different curves of unequal radius.

This cannot be altogether avoided at the landing of circular stairs. The wreath, however, may be very much improved by having no part of it on the landing fall exactly level.

The following method may be adopted:

Fig. 1 shows position of riser landing and that starting.

Let one piece of wreath stand over five winders. The pitch of this regulates all the others. The joints are now B, D, F. Draw the tangents A, B, C, D, E, F, which unfold on a board, (shown at Fig. 2.)

The letters along the margin correspond with those on plan. Square over a line, say that from A. Then set off two risers and a half. Next, set off two winders, and draw floor, cutting at E. This letter shows position of risers starting on plan to left.

We are now ready to draw the pitches.

Commence below, and join A S extended. Then draw from L, cutting through 4, and parallel with A S. Join 4.2. This is the pitch standing over the floor.

To find the heights, and a direction for ordinates: Draw through joint 3, cutting at R and P. Next,

square over from L, and up from P, giving P H as height for upper piece of wreath, and L H the direction for its ordinate.

Find the height of lower piece of wreath by squaring over S K, giving K R as height, and S K the direction for ordinate.

Draw this mould shown at Fig. 3.

Let tangents B, C, D equal those on plan having corresponding letters.

Make K S equal K S on the right. Join S B extended. This is the ordinate. Make the seat square with it, cutting through O. Next, draw from C and K parallels with ordinate. Let K R, the height, equal that of K R on the right. Join R T extended. You are now ready to draw the mould. See that S 2, 3 equal corresponding letters on pitches to the right.

Fig. 4 is the mould for upper piece of wreath. Let tangents D, E, F correspond with those on plan. Make D H equal H L on the right. Join H F, the ordinate. Make the seat square with it, and cut through the point which struck the circle.

Next, draw from E and D parallel with ordinate. Let P H, the height, equal that of P H on the right.

Draw from H through intersection of seat and ordinate. Extend this line to the left. The drawing is now ready for the mould.

Lines 3, 4 L, to be correct, must equal the pitches on the right, having corresponding letters.

You will see that no bevel is given for joint L; it being so near the minor axis as to make the line L 4 nearly parallel with the pitch on major axis. So that bevel could not be conveniently shown.

PLATE 34

THE STARTING OF SELF-SUPPORTING STAIRS, HAVING RAILS ON BOTH SIDES.

FIGURE 1. Nothing can exceed the graceful beauty and grandeur of circular stairs that start with double curves.

No rules can be given for its construction; the workman must exercise his own judgment in laying down a ground plan.

The small circle on the left should be contracted from the third or fourth riser, in order to give the wreath starting a proper easing from the mitre cap. It would be impossible to do this by having all parts of the circle equal distances from its centre.

Tangents P, L, K are drawn for a piece of wreath to stand over five winders. Its pitch regulates that starting from newel.

The wreath for large circle, on the right, stands over four winders; its ordinate being the riser line O B.

To give the construction of these moulds, would be simply a repetition of what has already been done for a similar situation of winders. Nor is there anything new in the side wreath starting from newel; it has already been shown in various posi-

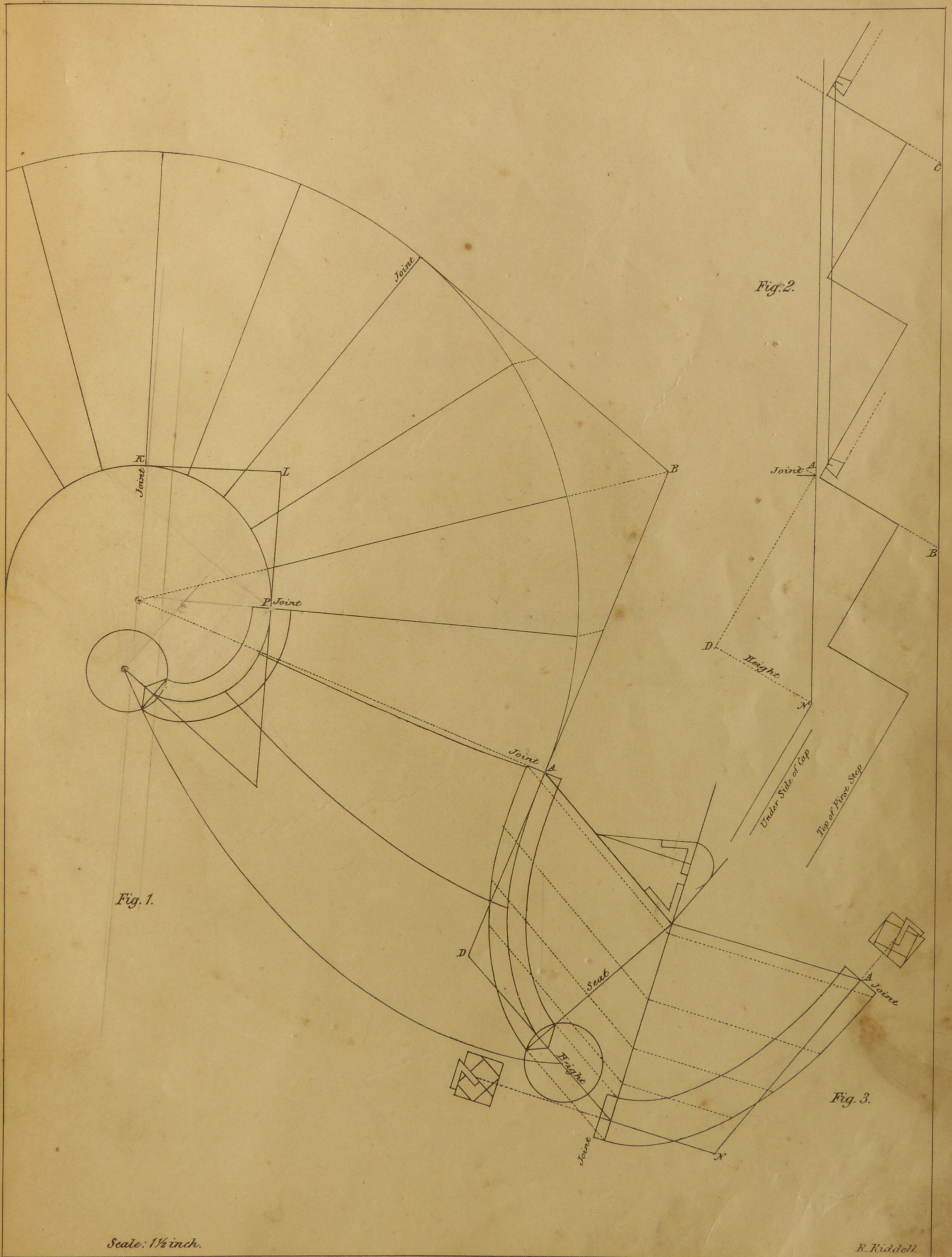
tions. The explanations, however, may be stated in few words.

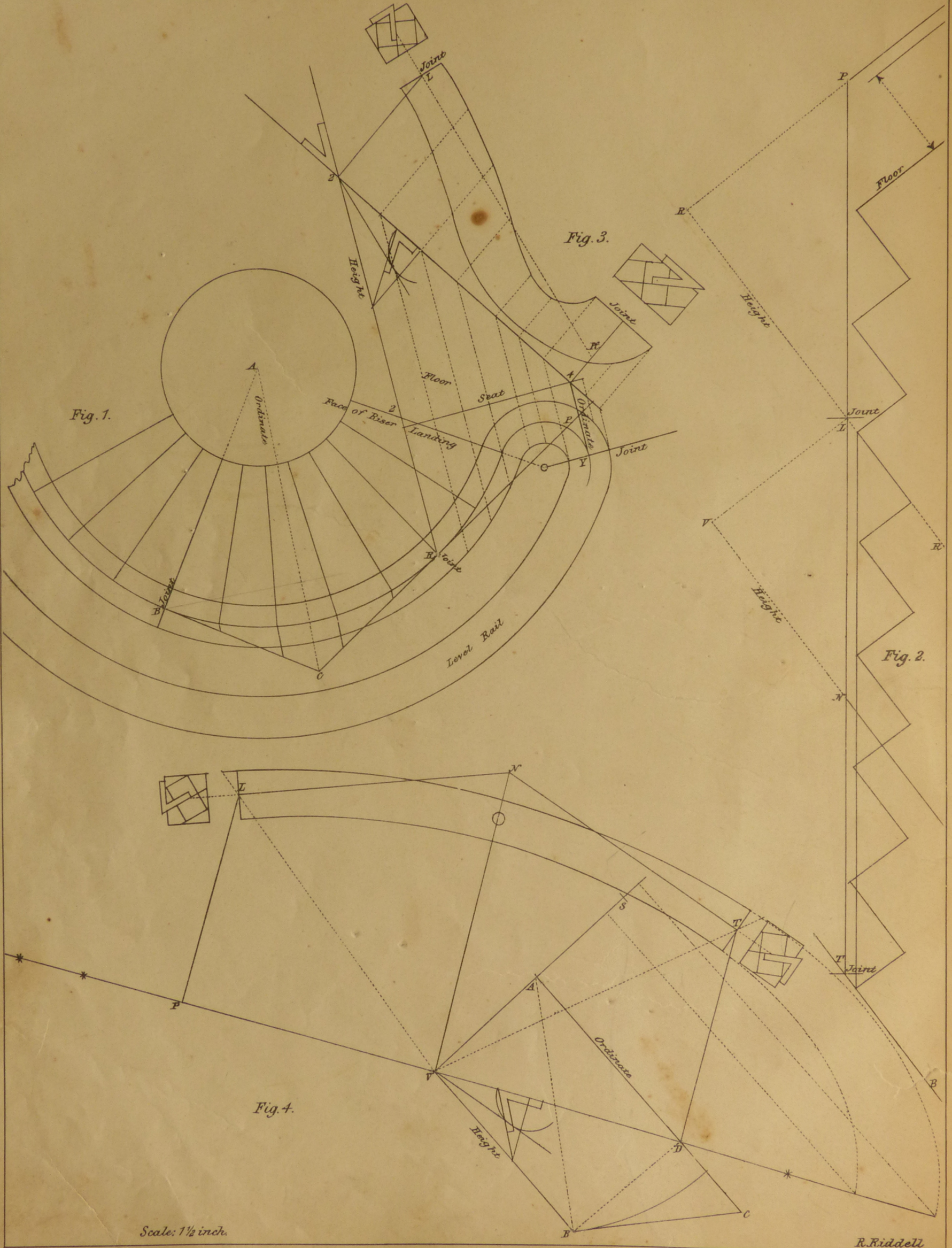
Fig. 2 shows the tangent A B and three of the winders unfolded. Draw top of first step. Now fix upon height of newel. Next, draw under side of cap to suit height of newel. Let under side of rail rest on centre of balusters. Set off half its thickness. This having intersected at N, gives height N D and D A as a direction for ordinate.

Let A D on the left equal it. This done, fix position of mitre cap. Then draw from D through its centre; this being the ordinate. Make the centre curve tangent to it, and that at A. Set off half width of rail on each side of centre curve. Then draw seat square with ordinate. Let height equal that of D N. Draw the pitch through intersection of seat and line from A.

Complete the mould by drawing a few ordinates.

The line A N, to be correct, must equal corresponding letters on the pitch, Fig. 2.





Scale: 1 1/2 inch.

R. Riddell

PLATE 35.

CONSTRUCTION OF WREATH, HAVING A DOUBLE CURVE TO LAND ON A LEVEL GALLERY.

FIGURE 1 shows the plan of a stairs, having the rail to stand over wide end of winders, and connect with small circle at the landing.

Determine position of joints, say B and R. This makes one piece of wreath stand over five winders, and landing wreath to connect at joint R.

Draw tangents B C and C R extended. Unfold the tangents and winders cutting them, as shown at Fig. 2.

Let under side of rail rest on risers standing over B and R. Set off half its thickness. Now determine on height of rail over the winders, say 2-2, perpendicular with face of riser. That is, from top of step, to under side of rail. Then fix upon height of level rail on gallery; say 2-9, to under side. Set off seven inches above floor. Again, set off half thickness of rail. This having intersected the pitch at P, gives the height.

Let R P on left, equal corresponding letters on right. Draw from P, touching centre of rail at Y. Or, lay a straight edge on O, and have Y P square with it.

Make the seat square with it.

Let 2-2, the height, equal that of L R on the right. Join 2. 4. This is the pitch. Square over 2 and 4.

Let 2 L equal 2 R. Make 4 K equal 4 P. Join L K. This line, to be correct, must equal L P on the right. Now draw a few ordinates, and complete the mould, as shown.

Fig. 4 is the mould for piece of wreath standing over five winders. It connects with that just done.

This drawing is made to take up the least possible space. Nothing can be more compact and neat.

Commence by drawing the right angle A, B, C to equal corresponding letters on plan. Join A C, the ordinate. Make B D square with it. This is the seat. Draw from B square with B D. Let B V, the height, equal that of N V on the right. Join D V extended. This is the major axis. Let V P equal V D. Square over the lines. Make D T and P L equal A D. Let V N equal A C. Join L, N, T. These lines must equal the pitch on the right, having corresponding letters.

Next, find the length of elliptic curves, by drawing from V square with V B. Let V S equal A B. Set off on each side of S half width of rail. Draw parallel with ordinate, cutting the pitch. Now find points for pins, and strike the mould with a string.

The pitches being equal, one bevel answers for both joints, as shown.

PLATE 36.

THE WREATHS FOR QUARTER-LANDING STAIRS, THE GROUND PLANS OF WHICH MAKE ACUTE AND OBTUSE ANGLES.

To have the wreaths in one piece, and the shanks stand on pitch of stairs. The face of riser landing and that starting, must stand half a step from intersection A, as shown at Figs. 1 and 3.

The method for position of risers has already been explained for stairs, the ground plan of which made a right angle.

The object of these drawings is to show that, although the steps and risers are on each plan precisely alike, yet the joints on wreaths require two different bevels.

To illustrate this: Let us draw the mould for Fig. 1. The line A C is the ordinate, as shown at Fig. 2. Right angle A, B, C corresponds with that on plan. Draw the seat from C square with ordinate. Make B N parallel with A C. Let C L, the height, equal that of B D on plan. Join L N extended both ways. This is the pitch. Square over the lines. Let N V equal N B. Make L P equal C A. Join P V extended, and that on the right in like manner.

Now, the line P V, to be correct, must equal A D on plan.

Find the length of elliptic curves by making C 2 equal C B. Set off on each side of 2 half width of rail. Draw parallels with N B, cutting the pitch. Next, find points to insert pins. Then strike the mould. It will be noticed that the bevel is obtained by drawing a line from L parallel with tangent on the mould.

Follow the same method for every wreath, no matter what its plan may be.

The mould for Fig. 3 is shown on the right.

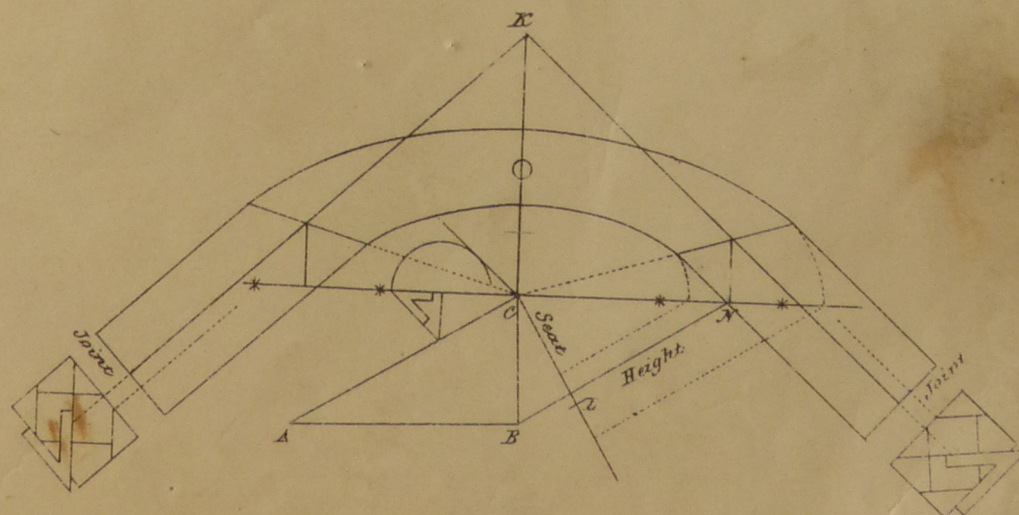
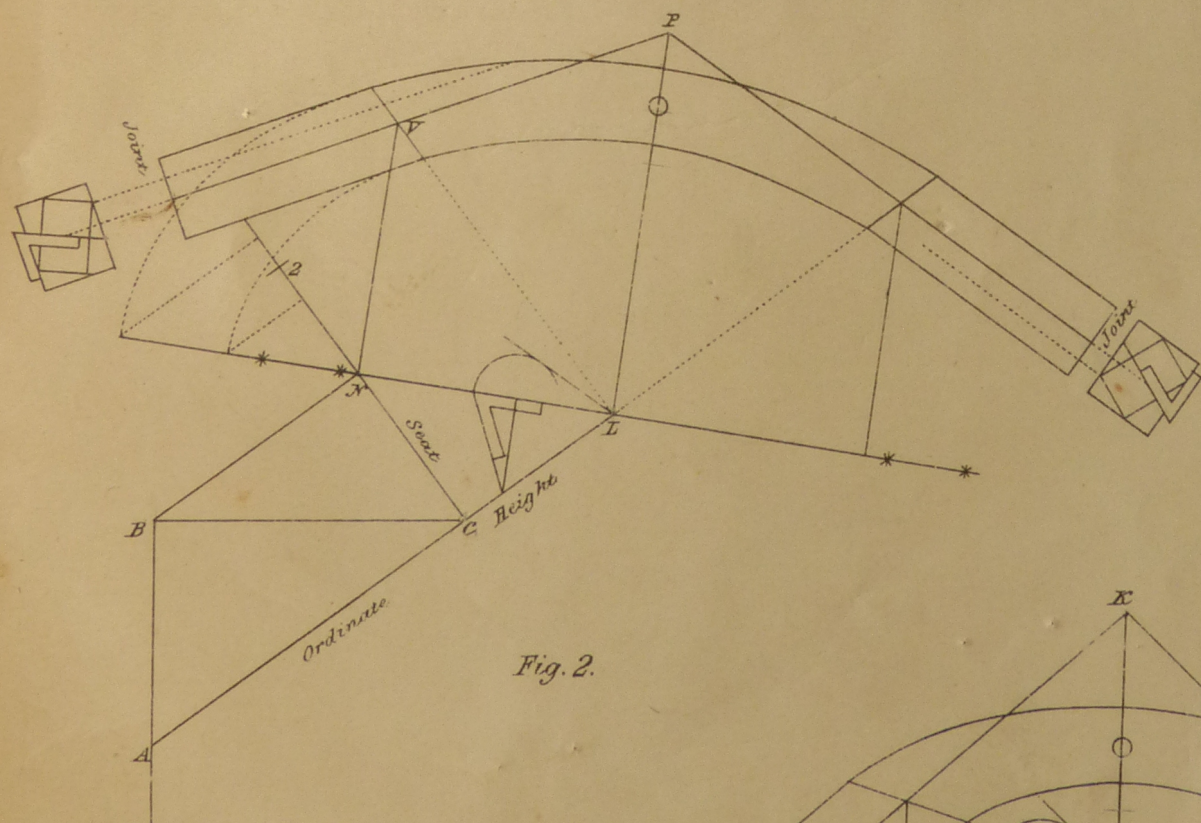
Letters A, B, C form a right angle, and correspond with those on the plan. Join A C. This is the ordinate. Make the seat square with it.

Draw from B parallel with A C. Let L N, the height, equal that of B N on the plan. Join N C extended. Square over the lines. Let C K equal C A.

The remainder of the drawing is sufficiently clear without further explanation.

The shanks of both these wreaths stand on the same pitch; yet, the bevels for joints are entirely different.

Remember this point in all practical operations.



Scale: $1\frac{1}{2}$ inch.

R. Riddell

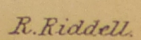


PLATE 37.

CONSTRUCTION OF WREATH WITHOUT A JOINT, TO GO AROUND A SEMICIRCLE AND FORM ITS OWN RAMP AND EASING—DIAMETER OF CYLINDER NOT LIMITED.

A SOLID wreath without a joint, may be successfully applied over winders landing on a level floor. Its lower part forms a perfect ramp; the straight shank thrown on the pitch of square steps. The upper part falls level, and forms the easing on landing.

It will, however, be understood that a wreath without a joint cannot be produced from plank, of same thickness as if made in two pieces; yet the additional material, to have it in the solid, is so trifling as to be scarcely worth mentioning. Especially when we come to consider the time saved in making joints, and the superior finish and effect of the work.

Still, I do not advocate the general adoption of this—workmen will exercise their own judgment in the matter.

It may be stated that a solid wreath can be produced from plank of a thickness equal to width of rail. But the joints in that case have to be made on the spring line; which is very objectionable, and at best but a shabby and make-shift affair. Therefore, it should not be adopted.

We will now proceed with the explanation of the drawings:

Fig. 1 shows the rail on the left, going up the stairs. It lands on a level floor.

The distance from centre to centre of baluster on line A 2 is thirteen inches. Draw the tangent from 2. Let 2.3 equal 2 A. Draw 3.4, touching the circle, and cutting at B. Then 3.4 is the ordinate, and equal with 3.2.

The position of riser landing and height of wreath must now be obtained, by making the elevation of one or two square steps, shown at Fig. 3.

Let under side of rail rest on the corners. Set off under side of level rail to suit long baluster on square step. Next, set off half thickness of rake and level rail intersecting at B. Let B A equal corresponding letters on plan. Square up from A, cutting rake at 2. Make O 2 equal A 2 on plan. Next, drop from O the dotted line, giving spring and distance A J. Transfer this to plan, and draw riser J. Set off a step to land.

We are now ready to produce the mould at Fig. 1 by drawing lines from A 2 and centre, parallel with 3.4. Make the seat square with 3.4. Let 3.2,

the height, equal that of O C, Fig. 3. Join 2 L extended both ways. This is the pitch. Square over the lines. Let 2 P equal 3 B. Make L C equal L 2. Join 2 C extended. Next, draw P K parallel with 2 C. Join C K. This gives the joint on the landing. Let 2 S equal 3.4. Draw from S parallel with 2 L. This gives major axis.

Now prove the drawing. The line 2 C, to be correct, must equal that of corresponding letters at Fig. 3. Again, P K must equal that of B 2.

This being all right, find the points to insert pins; then strike the mould with a string.

A word or two on the application of this mould:

First, observe joint K. This, when in position, ranges with joint 2 on plan. The line K P is on the surface of stuff; it stands on the pitch of stairs. Then, the joint K being plumb, the slab K P is cut off square with it, and falls to a level. Observe Fig. 5.

The slab is shown on upper surface.

It is now clear that a square cannot be applied to this joint. Then the best method to prepare the mould is to draw the lines H H parallel with major axis. Lay it on the stuff. Mark and cut square through. This being done, have the edge through H H square with surface.

The next consideration: We cannot work through half the thickness of stuff, the same as for any other wreath. Because, the additional thickness required is on the lower surface; and the slab cut off of the upper, as Fig. 5 shows.

This is further illustrated below Fig. 1, as line L K shows the pitch across the cylinder, it being equal to C K, Fig. 2. The corners of square sections are fair with upper surface of plank, and show the additional thickness of stuff on lower surface.

This understood, set gauge to F E. Run it on the edge; then square over H H. Next, let the bevel H pass through intersection on the edge. Now, lay the mould on. Let H H stand opposite bevel lines.

Mark the stuff along the edges of mould. Adopt the same application for the under side. The bevel D applies to joint on shank. Bevel H also gives it, although a very different angle to that of D; yet both bevels produce the same result on the shank.

PLATE 38.

CONSTRUCTION OF A WREATH IN THE SOLID STARTING FROM THE LEVEL FLOOR.

To produce on a pure principle of construction, a wreath without a joint, is a problem in practical geometry the most beautiful that has been applied to the science of HAND-RAILING; and is a subject of such value and importance as to induce me to show it in a still different position to that given in preceding plate.

There is no limit to the size of the cylinder; the only point to be fixed being the location of the riser starting, and even this is determined with great nicety.

Here the additional thickness of plank is on the upper surface, and the slab cut off of the lower.

Fig. 1 shows the ground plan, the centre line of rail being given, and half its width set off on each side. Let the tangents SK and $6K$ equal diameter from centre to centre of rail. Extend $6K$ both ways, cutting at 4 .

We must now find the position of riser starting. Also height of wreath by making the elevations of a square step and the floor as shown at Fig. 2.

Let under side of rail rest on corners of step. Have the under side of level rail above floor to suit long baluster 2.2 on square step. Set off half thickness of both rake and level; which intersect at D . Let DC equal $A4$ on plan. Next, draw a line through C , cutting the rake at H . Then set off from C the diameter, as shown by dotted line on the right, cutting at E . Next, square over EF , which gives FH for height, and AB for position of riser. Transfer this to plan, and draw riser B . Then set off a step and draw face of riser starting.

Next, make the seat square with ordinate $6K$. Let KJ , the height, equal that of $H F$. Join JL . Square over the lines. Let LO equal L and centre of joint. Join JO extended. This line, to be cor-

rect, must equal EH , Fig. 2. Let JN equal $K4$. Then draw from N , cutting at E , and parallel with JO . Join OE . The line NE , to be correct, must equal DH on the elevation. Again, OE must equal EC .

These lines being proved correct, proceed and draw the major axis, as shown.

Now find points, and strike the curves. Let VV on the mould be parallel with JL . Have the stuff cut square through. Joint the edges VV square with surface of plank. This done, square over VV across the edge. But, before proceeding any farther, notice square section at Fig. 1, where it is seen that the additional thickness of stuff required for this wreath is on the upper surface. The line OO being parallel with EC . Then we have 3.3, which transfer to square line on edge of stuff VV , measuring from lower surface.

This gives points to apply bevel V .

The lines which it makes on the edge direct the application of mould to both sides of stuff.

The slabs being cut off, and the wreath having its cylinder form, you are ready to make the joint through E , and that on shank. But, if preferred, the joint on shank may be made at once in the usual way, as bevel T produces the same result on shank as that of V .

This may seem strange when the angles are so entirely different. It is owing to the manner in which the bevels are applied. The stock of V stands parallel with pitch JL , whilst that of T stands square with line OV .

Fig. 4 shows the wreath worked to its cylinder form. The slab PR is cut off the lower side and square with the joint.

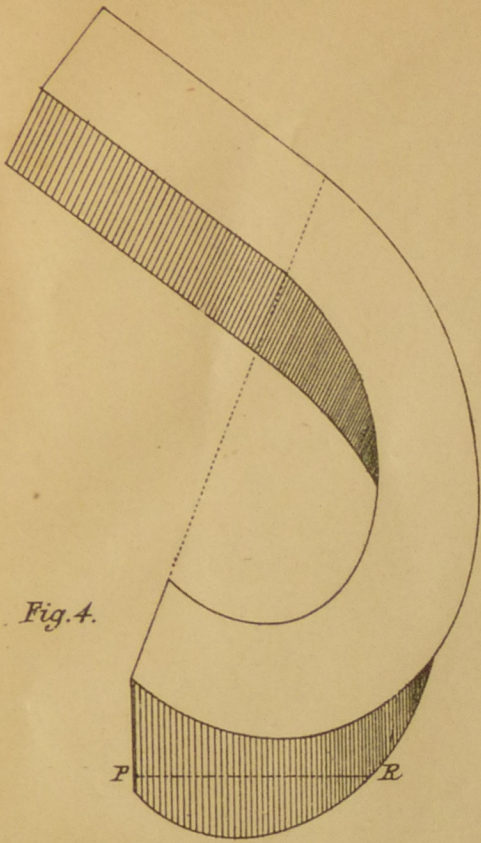


Fig. 4.

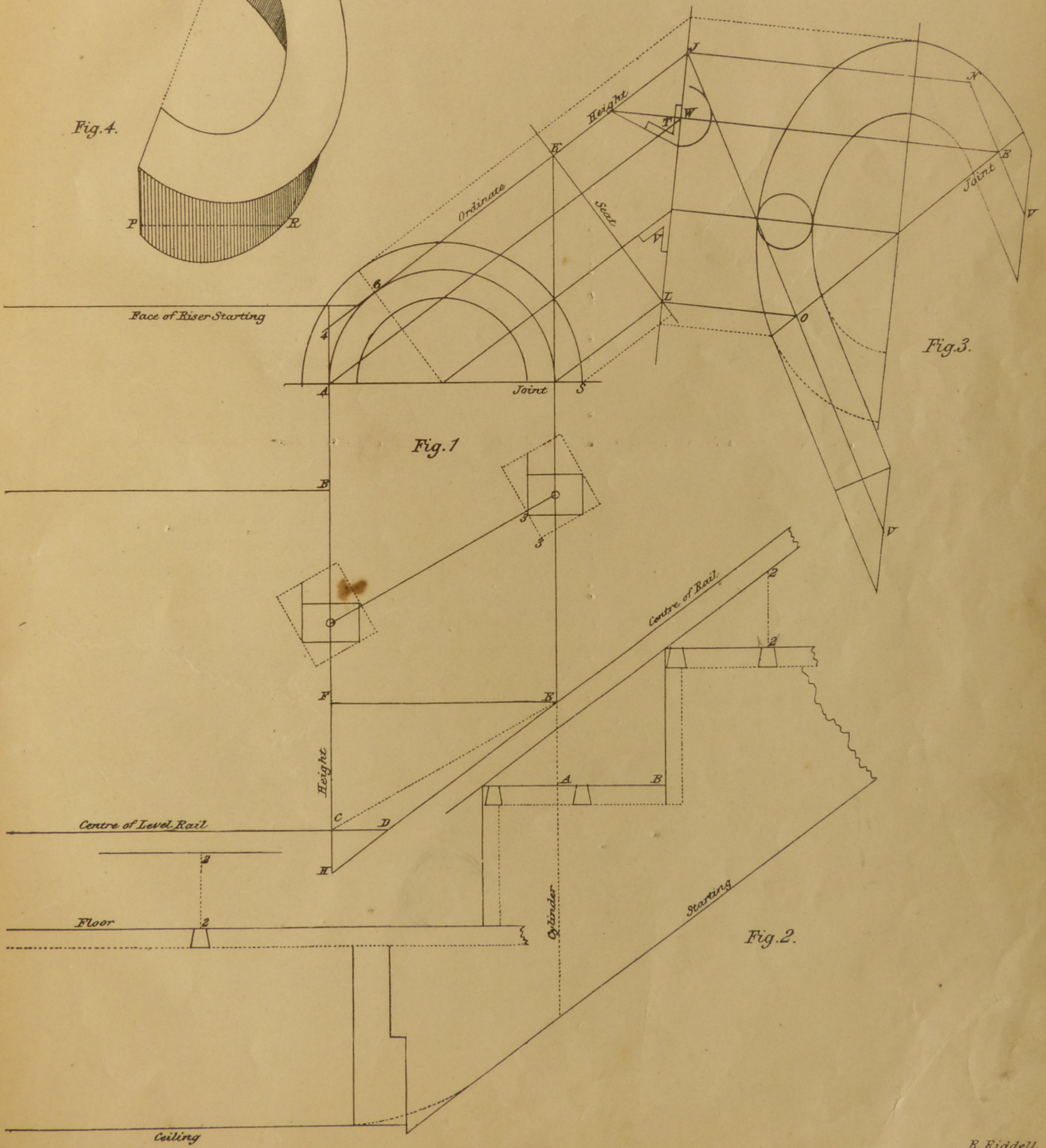


Fig. 1

Fig. 3.

Fig. 2.

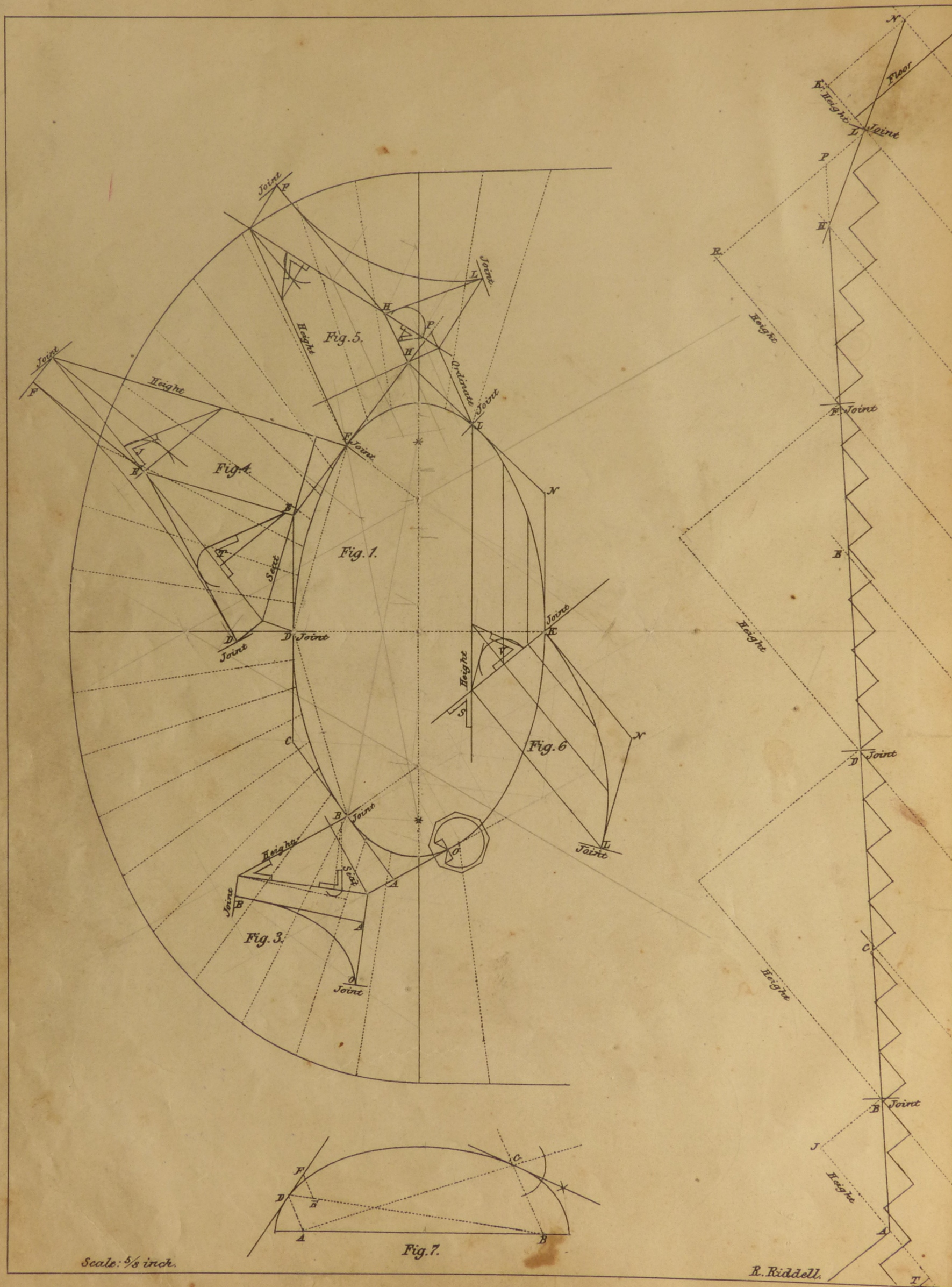


PLATE 39.

CONSTRUCTION OF WREATHS FOR ELLIPTICAL STAIRS.

FIGURE 1 exhibits the ground plan of stairs. The centre line of rail given.

The moulds must be produced by ordinates. Not that it is impossible to strike them with a trammel; for, undoubtedly, the curves on wreaths are elliptical; but, to find the centres and diameters of these curves, would make the drawing both intricate and complicated, causing unnecessary loss of time, to no particular purpose.

The best method to adopt for stairs of this description, is to lay down the centre line of rail, and set off half of its width on each side. Then fix upon position of joints, say B, D, F, L, and K, on landing.

This arrangement makes the piece of wreath that stands over D F answer for D B. It being reversed, the joint B, and that of F are at equal distance from D. Again, the angle of tangents at both places being exactly alike, makes the ordinate a right angle with chord D F. That is, provided the position of wreath runs on a straight line from B to F. The wreath starting from newel, one of its tangents must be level.

This, in all cases, is the ordinate.

The same remark applies to the wreath landing. Its ordinate being K N. The heights of wreaths and construction of moulds are obtained, as usual, by unfolding tangents and winders. These are shown on the right.

The letters on pitches agree with those on the plan.

The whole construction is similar to that which has already been given for circular and other stairs. Therefore a detailed explanation of this plate will not be required.

It was thought best to omit the width of moulds in order that the drawing might be more easily understood.

The tangents on the moulds and the bevels being the most important points, these are obtained and applied in the same manner as those of circular stairs.

We will now notice the heights:

That for the first piece of wreath, starting from newel, is A J, which agrees with that of Fig. 3 on the left, and the lines A B, at both places, are of equal length; and thus the mould is proved correct.

Fig. 4 shows the tangents and bevels for mould, which answer for two pieces of wreath from joint B to F.

Its height agrees with that shown over B or D on the right.

Bevel T applies to joint D, and bevel J to joint F.

Fig. 5. The ordinate for this mould is obtained by extending tangent F, H.

Let F P equal R P on the right. Join L P, the ordinate. Let the line marked "Height" equal that of R F on the right. Bevel H applies to joint L; and the bevel on the left to joint F.

Tangents on the mould, to be correct, must equal pitches on the right. Letters at both places correspond.

Fig. 6. This mould being for piece of wreath landing, its tangent and ordinate is N K. The height equals that of L K on the right. Tangent L N, to be correct, must equal pitch L N on right.

It will be readily perceived that the whole of this process is a repetition of the methods which have already been adopted for producing moulds and bevels. The only difference is the curves, which must be obtained by ordinates.

There are one or two other points that it may be well to mention. First: There can be no question or doubt as to the chaste and beautiful effect of elliptical stairs; to execute which both skill and judgment are required: And more especially in the height of rail, which is a most important point.

Let any one notice the hand-rail of an elliptic stairs, and stand on winder B. Here we find the rail too low. Why is this — the baluster is the same length as that at D, and yet there is a great variation in the height of rail?

The cause of this is owing to the position of the winders and tangents, which is fixed and unalterable.

Observe tangent through B. It and the winders do not stand at anything like a right angle. The risers are thrown forward toward the newel, and approach us more rapidly, when going up the stairs, than those at D, where the tangent and winders are nearer a right angle, and where the rail is a proper height.

But go on a little farther, and stand on winder F. Here we find the rail *too high*, for the reason that the winders are receding from us, and the pitch of rail at this point is much greater than it is at D.

Notice mould, Fig. 4. The tangent E F, being shorter than E D, shows that the wreath stands on two different pitches, yet is parallel with the nosings when in position.

Nearly all elliptical stairs are executed in this manner, and the defects just named may be detected by any one. Then the question arises, How can these objectionable features be removed? or, what means should be adopted to equalize the height of rail to suit the winders?

Let us, for a moment, examine the tangents on the plan.

Take for example that of C E. It must be a straight line on the pitch, because there is a joint at D which is stationary and fixed. But C may be raised, and E lowered. This at once changes the pitches of rail, and, of course, the height of balusters at B and T.

This simple remedy counteracts the evil, and throws the rail into a proper position, to suit the hand going up or down the stairs.

The next consideration is the bending of wall and front strings. These are usually bent over a cylinder or form; a method both tedious and expensive.

Let kerfing be adopted, and the work is done in half the time; besides being a much better job. The only difficulty is the plan, it being a perfect ellipse, which makes kerfing impracticable. Then change the plan to a figure that will nearly resemble the ellipse. This can be done from centres of unequal radius, thus making kerfing entirely practical for the strings. This point, however, will be more fully explained in the following plate.

Fig. 7 shows two methods for tangents to elliptic curves.

From A and B draw the foci A D and B C. Join B and D, and A C. Bisect the angle on the right, and through the intersection draw the tangent.

Second method, on the left. Take any point, say E, and draw E F parallel with A D. Make E F equal to A D; and draw the tangent.

PLATE 40.

ELLIPTICAL STAIRS—WALL AND FRONT STRINGS BENT BY KERFING.

THE ground plan of these stairs is struck from centres A, B, C, D. The principle being the same as that laid down in the first plate.

By the use of more centres than are here given, the figure could be made to present a more perfect oval. But, such a method would cause the kerfing to be complicated and rather difficult.

The chief object to be had in view, is to show a method of bending the strings with the least possible amount of work.

It is true, that the figure under consideration may not present to the eye those beautiful curves created by a pure ellipse: but we must bear in mind, that the plan we look upon is on a flat surface, and therefore incapable of giving even a remote idea of that long extended rising curve which in its elevation would seem to sweep far beyond the limit laid down for it on the plan. And yet, the strings stand directly over this flat representation.

Viewing this stairs from an upper floor, and looking downward, perhaps a better idea may be formed of the curve on its stretch-out; but even then, not one in a hundred could fairly decide whether the plan was a true ellipse or its imitation.

There are very many objections (some of them serious ones) to the old and slow method of constructing circular strings. Just think of the amount of labor thrown away in building cylinders, forms,

and other fixtures, for no other purpose but to bend strings over.

This tedious and expensive mode may be entirely dispensed with, by the adoption of the new and much advanced system of kerfing; which I certainly would not advocate in this work, if there was *a single doubt* as to its practicability. But, having seen kerfing thoroughly tried, and its application to bending, not only strings of stairs, but other work, practically tested in such a manner as to leave no doubt whatever of its perfect reliability, I have not the least hesitation in urging its adoption in all cases where certainty of effect, shortness of time, and economy of material, are matters worthy of consideration.

In conclusion, I would say, it is thought that the explanations are sufficiently clear, and I am fully confident that the drawings comprising the several plates, are in themselves perfect; for, from close and constant inspection, I can state with certainty that there is not a single error in any one of them. So that the workman can be fully assured of the correctness of every line, and depend with confidence on the truth and certainty of all and each of the instructions contained in this volume; which shows the art of STAIR-BUILDING fixed on a firm basis, and made a perfect and pleasing science.

R. R., 1214 Hancock Street,
Philadelphia.

